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Electronic Business®

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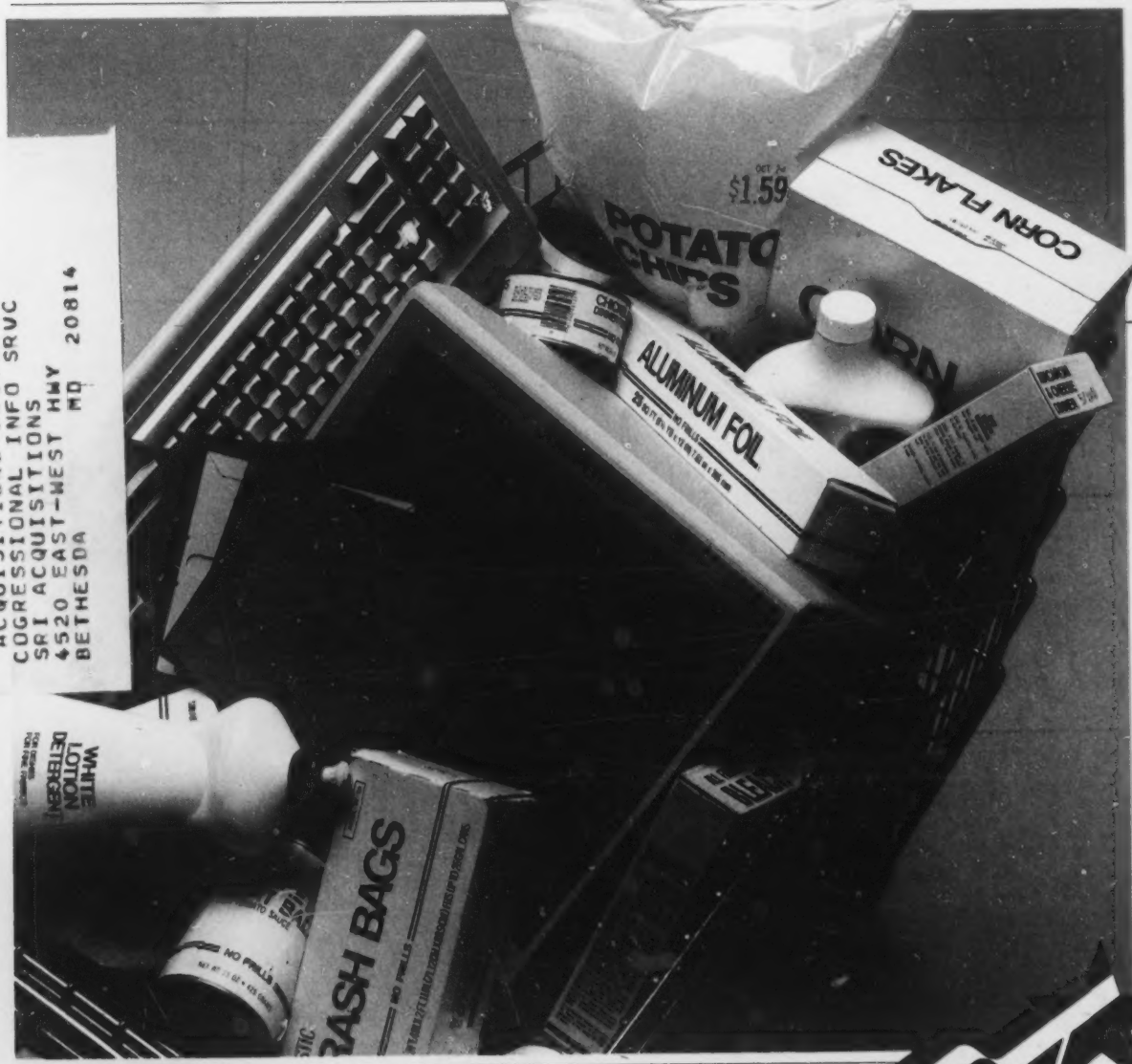
Analogic's Gordon: Turning engineers into managers PAGE 22



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Keeping America Competitive
Implementing JIT

VOL. 13, NO. 21

Electronic Business

NOVEMBER 1, 1987

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BPA ABP

Good sign: Distributors' shipments pass the 1984 peak

An even better sign: This time it took twice as long to get to the peak

The distribution shipments index, which the National Electronic Distributors Association compiles from a sample of its members that represents more than half the sales of industrial electronics distributors in the United States, peaked last June at a level of 2.24. (That is, 124% more than the index's base from May 1980.) This level is significant because it edged out the previous record of 2.23 from March 1984, a period which many electronics market watchers, and certainly many distributors, still fondly remember as the good old days for electronics activity in the United States.

Some, however, watching the level of shipments retreat during the summer, see a dark side to the significance of this peak. Is this the highest level the distribution business can attain, only to be followed by another drop in its roller-coaster pattern? Not to worry; for distribution sales attained those two peaks in very different ways. It took two full years for the shipments' index to climb from the recession's low point — 1.62 in July 1985 — to the recent high. By contrast, it took less than nine months last time for the index to cover similar ground, from 1.54 in July 1983 to 2.23 the following March.

The implication is that the current level of activity, while higher than in 1984, is on far more solid ground; but the fact is that shipments dropped during the summertime, along with a retreat in NEDA's book-to-bill ratio.

There are, fortunately, positive reasons for this decline. The book-to-bill ratio peaked last April at 1.12, a value that says orders are coming in ahead of shipments but at a far more manageable rate than they did in 1983-1984, when the ratio stayed uncomfortably above 1.20 for more than six months.

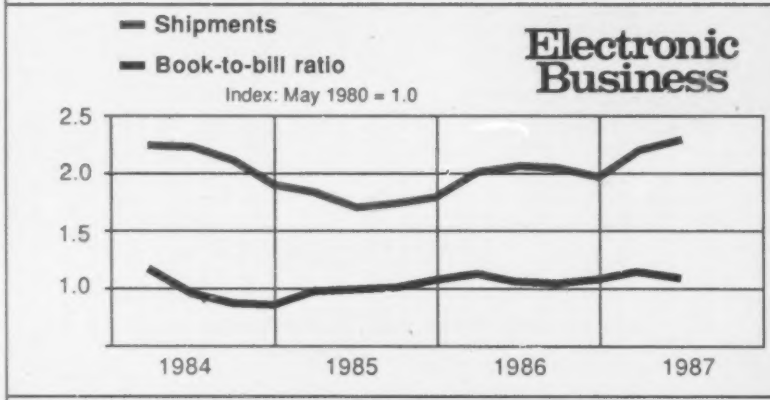
One factor which may have contributed to shaving a few points off the book-to-bill ratio is the increasing number of distributors offering just-in-time programs to their customers in an effort to keep those customers from going directly to components manufacturers for JIT supplies. From the customer's point of view, the immediate impact of a JIT program is that it reduces leadtimes.

Unfortunately, a side effect of JIT is that to maintain such a program, a distributor may be forced to build its own inventory. This happens when the components manufacturer is not very efficient or cooperative in holding up its own end of the JIT program, or simply does not want to participate if the volume is low. "The trend is for the manufacturers to give up the bottom 3% of orders," says Morton L. Mandel, chairman of Premier Industrial Corp. of Cleveland.

Encouragingly, profits for distributors are slowly returning after a long drought. The second quarter was profitable for the largest distributor, Avnet Inc., while its sales increased 12% over the year-earlier quarter; this matched closely the increase for NEDA's shipments index. More profitable, relative to their sales, were Premier Industrial, which showed a sales increase of 8%, and Marshall Industries, which recorded a 15% gain in quarterly sales.

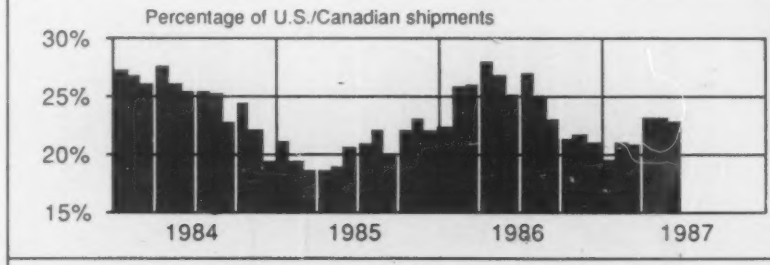
ALBERTO SOCOLOVSKY

Distribution business index



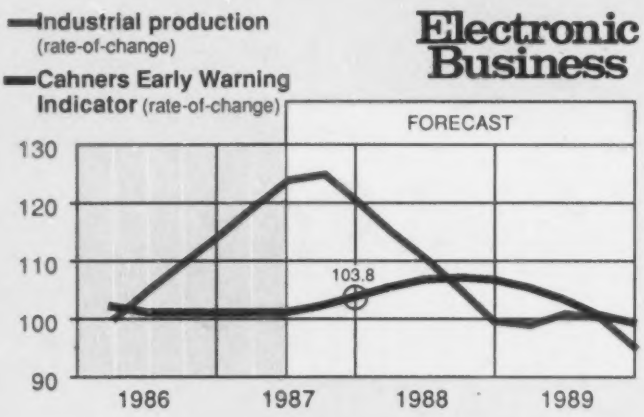
Source: National Electronic Distributors Association

Distributors' share of IC shipments

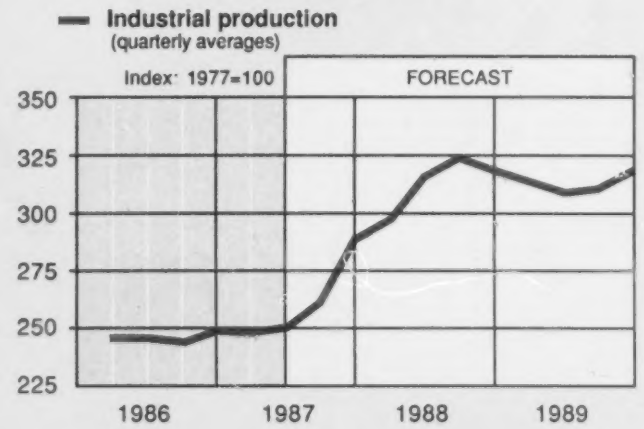


Source: Semiconductor Industry Association

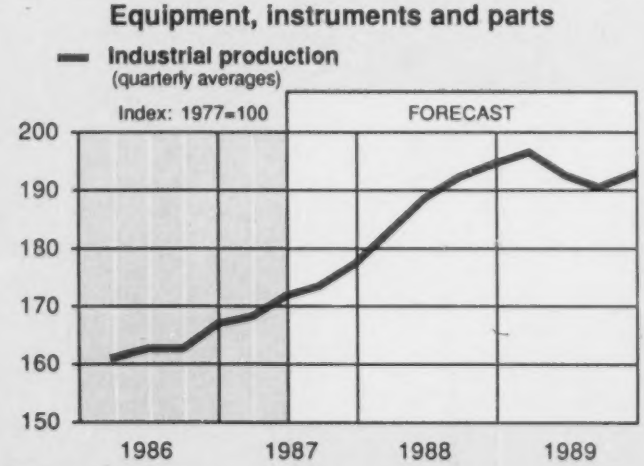
Economic indicators



Electronic components



Equipment, instruments and parts



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. This spring, output rose 0.7%, according to estimates from the Federal Reserve Board. This slow and steady growth is expected to continue until next summer. Production is expected to rebound after a year and a half of sluggish growth pushing production up 6.8% in 1988.

The Cahners Early Warning Indicator has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. This leading indicator, (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index, has proven to be an excellent forecasting tool. It forecasts the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.8 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.8% above 1986.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Equipment, instruments and parts

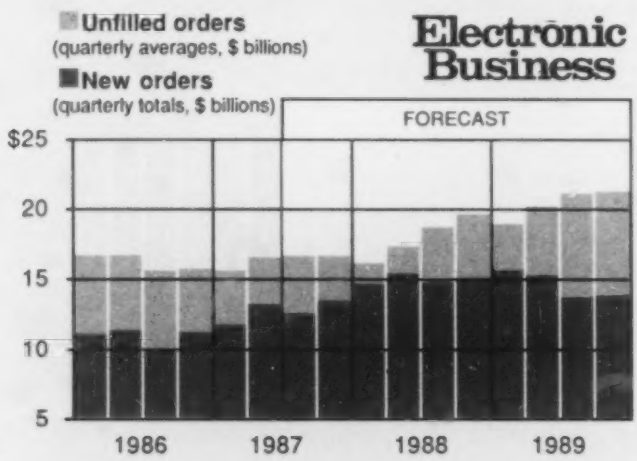
Production of scientific and engineering instruments jumped 6% in the second quarter from the year ago level. A quarterly growth rate like this has not been seen since 1984. Output is expected to pick up even more in the second half of 1987, leaving production for the year 6% above 1986's level. Increasing demand for more precise and automated instruments such as chromatographs, sensors and other measurement equipment is expected to boost production by 9.7% next year. In 1989, with industrial growth slowing, output should rise only 1.9%.

Electronic components

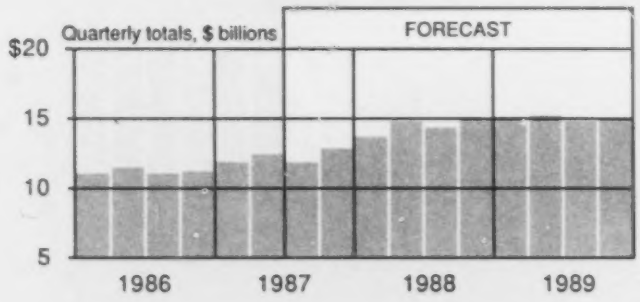
Electronic components output rose 0.8% in the second quarter of 1987, putting it 2.1% above the year ago level. The second half of 1987 should see a more substantial 11% gain. Next year is expected to be the industry's banner year, with component production growth of 20%, its best annual performance since 1984. By next summer, components output is expected to set a new record, rising 11% above its previous peak production level set in 1984.

Electronic components (SIC 367)

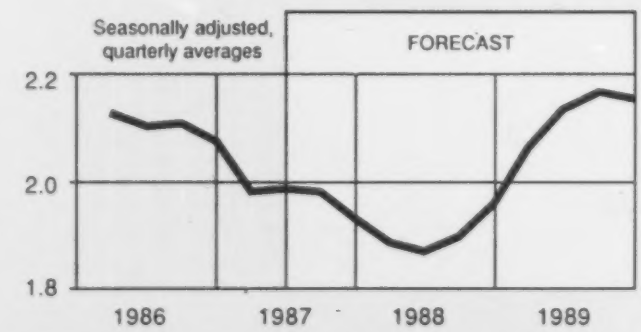
New and unfilled orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

Orders for electronic components surged 12% in the second quarter of 1987 to $13.1 billion. Despite some sluggishness in component production in early 1987, orders are up strongly over year-ago levels, which bodes well for the continued recovery in components. By the end of 1987, orders are likely to total $50.6 billion, 17% more than 1986. Next year an 18% gain in orders placed by domestic computer makers and export markets should put the components market back at record-breaking levels. A short and mild cyclical downturn is expected in 1989 when orders may dip 2.5% to $58.4 billion.

Unfilled orders

With new orders on the rise, backlogs of components are expected to soon begin rising sharply, mirroring previous business expansions. In June, unfilled orders reached just $16.5 billion, 6.5% above March's level, but unchanged from a year earlier. By the end of 1987, backlogs are expected to have gained another $100 million. Over the next two years, backlogs are expected to expand to $19.5 billion by the end of 1988 and $21.3 billion by the end of 1989.

Shipments

Shipments of components totaled $12.1 billion in the second quarter of 1987, 2.4% above first quarter shipments and 6.9% above last year's second quarter showing. This was only 2.5% short of the $12.4 billion shipped in the second quarter of 1984. While the growth rates in the current expansion will be more modest than in past recoveries, record-breaking dollar volume shipments will be the rule for components next year. Expect 17% growth in 1988 to $56.7 billion and 4% in 1989 to $59.1 billion.

Inventory-to-shipment ratio

Tight inventory management in conjunction with rising shipments forced the components inventory-to-shipment (I/S) ratio down last summer to 1.99, from 2.03 in April of 1987 and 2.13 in June 1986. The I/S ratio has headed down fast, with lower ratios being the rule for most electronics markets and many other manufacturing concerns. The high cost of credit in the early 1980s has taught manufacturers to keep inventory tight. By December 1987, the components I/S ratio is likely to stand at 1.92, only 11 points higher than its June 1984 ratio, its lowest ever.

ELECTRONIC ASSEMBLY

The robots that look better now

Sharp new vision systems have electronics assemblers making eyes at robots

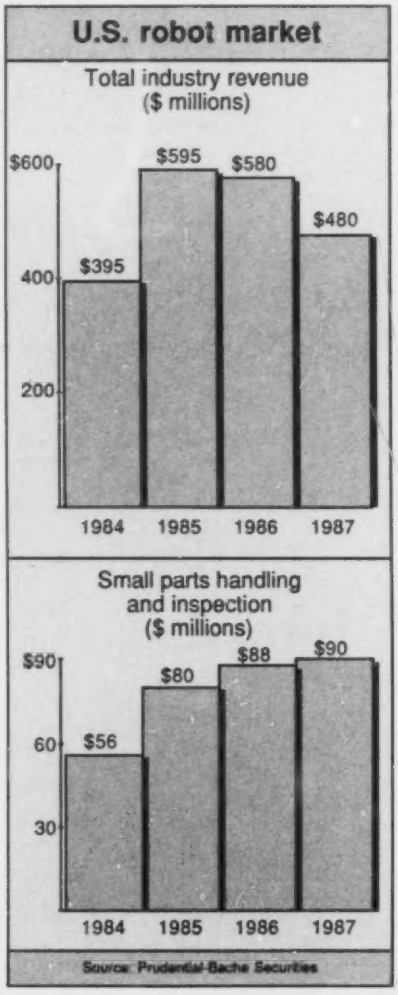
The past two years haven't been kind ones for the U.S. robotics industry. Revenue has fallen as automotive applications, such as painting and welding, have matured and become saturated. Robot industry revenue peaked in 1985 at $595 million and will fall to about $480 million during 1987, according to Laura Conigliaro, first vice president for Prudential-Bache Securities Inc. in New York City.

However, while the overall robot market has faltered, one sector — small parts material-handling and inspection — has continued to grow slowly, and will move from its 1985 level of $80 million to about $90 million this year, Conigliaro predicts. Dealing largely with electronics assembly applications, this sector has been inching forward, thanks in large part to the advent of affordable and accurate robot vision systems. High-end, standalone vision systems are also playing an important role in speeding up the inspection of components such as multilayer printed circuit boards.

Adept Technology Inc. of San Jose, a relative latecomer to the robotics market, is the clear leader in the small parts sector, and could realize revenue of approximately $35 million for 1987, Conigliaro says. Intelledex Inc. of Corvallis, Ore., is "the Avis to Adept's Hertz," says Intelledex vice president for marketing, William Mahoney. Also ranked a contender in the small parts handling market is Seiko Robotics, a division of Seiko Instruments USA Inc. in Torrance, Calif.

About 35% of Adept's robot systems are sold into electronics assembly applications, and about half of these systems are equipped with the company's vision equipment, says product manager Dave Scarborough. These percentages are almost identical to those at Intelledex, according to Mahoney. Both companies sell primarily through systems integrators, which configure the products and write programs for specific customer applications.

Vision capabilities have become increasingly important because the technology of the robots themselves is fairly static. "We look at our robot product as a core," says Mahoney, "and then look at what we can do to make it faster and more usable. Adding vision is an obvious way to achieve that enhancement."



Crude vision systems have been around for some time, but they've come into their own in recent years. Most advances have been in the software realm rather than in hardware. New algorithms efficiently perform tasks such as determining an object's presence or absence, locating circles and their centers, and finding the edges of objects. Each vendor has built up its own standard library of such algorithms and claims that this standardization has dramatically eased the job of system development.

Adept has also developed a programming environment called Assembly and Information Manager (AIM), which Scarborough says has contributed greatly to the firm's market leadership. As well as Adept's vision algorithms, AIM includes a "task level language," he says. Using this language, systems integrators can, for example, employ one command to transfer a part to a certain location; the high-level command contains all the detailed logic required to accomplish the task.

AIM also capitalizes upon the fact that the vision and robotic portions of the system are totally integrated. An AIM-developed program can freely intermix motion and picture-taking instructions, as opposed to requiring distinct programs or subroutines to direct the two components. Adept and its competitors all point to such integration as a key advancement from the days when rocket companies made robots and vision companies made vision systems. Mixing and matching such independent systems poses a daunting integration task, and can often prevent either the robot or the vision system from operating at its peak capacity.

As the robotic vision systems have grown more capable, their prices have also dropped. A system that might have cost $40,000 two or three years ago can now be had for $10,000 to $15,000. These prices, coupled with the new ease of developing vision-based systems, have coaxed a large number of once-skeptical systems integrators to take another look at vision.

Grasping properly

In typical electronics assembly applications, the vision systems assist the robot by locating a part, determining its orientation so that it can be properly grasped, and directing the subsequent placement. Adept's sys-

tems, for example, often employ two cameras, one on the robot arm, and the other inverted and stationary. The robot uses a vacuum to pull a component from a tray and then moves it over the inverted camera to determine the part's position relative to the position of the robot arm. The arm camera then sights fiducial marks on the PC board, giving the system a frame of reference to insert the component.

Robotic system cameras can perform fairly gross levels of inspection, such as surveying a part's presence, its orientation, and even the spacing between its leads. But for more complex inspection tasks, such as detecting errors in the artwork of multilayer printed circuit boards, more sophisticated vision systems are required. These systems, typically referred to as automated optical inspection (AOI) systems, can cost half a million dollars and rely upon advanced pattern recognition and artificial intelligence techniques to perform their tasks.

Two companies dominate the AOI market: Orbot Inc., based in Woburn, Mass., and Optrotech Inc. in nearby Billerica. Orbot did more than $15 million worth of business in the first six months of this year, according to president Hai Benron, who claims his firm accounts for half of the entire AOI market. Unlike the robot vision companies, the AOI companies sell their products directly to end users.

For the hefty price of the AOI systems, buyers can achieve faster and much more reliable inspections of their boards than human inspectors can provide, resulting in better yields, less scrap, and higher revenue, Benron says. The Orbot system can scan up to 32 square feet per minute at a gross level of resolution, and although speed drops as the resolution increases, the system still easily outruns human inspectors.

Given their prices and capabilities, the high-end AOI systems have little in common with the integrated robotic vision products. Still, both types of systems are proving their ability to give manufacturers a critical edge over non-automated competitors. As a result, for both the assembly and inspection stages of electronics manufacture, companies are beginning to view vision systems of all types as required components for successful operations.

DWIGHT B. DAVIS

INTEGRATED CIRCUITS

What users want from graphics chip vendors

Flexibility and speed are just two of the features that graphics equipment makers want in their ICs

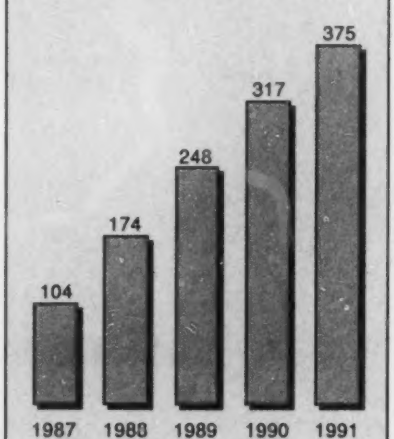
Graphics chip designers have gone back to the basics recently in an attempt to find new ways to reach somewhat jaded computer users. What they have found, according to one graphics equipment manufacturer, "is that the object of graphics companies is to replace paper and pencil functions with graphics functions. Only when we do this will we meet peoples' expectations."

Trying to meet users' needs today are a bevy of high-end and mid-level graphics solutions that offer functionality that is, in some cases, 10 times better than previous products. Even today's low-end products are considered "high end" when compared with the levels of functionality available several years ago.

At the high end, graphics equipment typically demands high resolution — at least 1,000 lines on a screen. It often calls for high speed, for three-dimensional manipulation of images, for palettes of thousands of colors and for complex shading of the displayed objects, to make them appear more realistic. Graphics chips are also required for proliferating low-end applications such as banking terminals, video games and even the electronic displays inside an automobile.

High-end PC graphics and imaging board sales

(U.S. sales, thousands of units)



Source: Dataquest Inc.

Historically, graphics were generated more by software than by hardware, were often slow, suffered from the "jaggies" (the way in which low-resolution graphics present diagonal lines as a series of steps instead of as a smooth line) and were far from the quality demanded by both business and scientific users.

Today, the mechanics have changed, as sleek new graphics chips step in to substitute for the overworked central microprocessor. Not surprisingly, the market for these highly functional chips is growing rapidly.

According to San Jose-based market research firm Dataquest Inc., U.S. vendors will ship 104,000 units of high-end intelligent graphics and imaging controllers in 1987, and that number is forecast to increase to 375,000 by 1991.

Graphics controllers are not the only graphics chips in demand. Video RAM integrated circuits are also required to store the massive amounts of data contained in, say, a 3-D image. And users are calling for application-specific graphics chips too.

Stalking graphics standards

The solutions offered today by chip designers all offer a high level of performance, but that is where the similarities end. As with many new markets, there are daily battles over standards, over single versus multi-chip solutions, and over prices.

As one graphics chip manufacturer puts it, "Each of the six major manufacturers has chosen to approach high-end graphics in a different way." As if that weren't enough of a problem, IBM recently threw the graphics

industry into disarray with its Personal System/2 graphics standards announcements, including the Video Graphics Array (VGA) standard, as well as its new, higher end 8514 standard. Now the industry, which has struggled with standards such as the Enhanced Graphics Adapter (EGA), will have to draw some battle lines.

According to Dataquest's senior industry analyst Michael Tyler, IBM's entrance into the market does not confuse matters; it validates the market. Tyler characterizes the VGA as a fairly low-end standard that will have little impact on the high-end. Meanwhile, the 8514 will crystallize high-end standards, he says, and give vendors in this market, whose equipment has traditionally not been IBM-compatible, a flag to rally around. All this can do, he says, is boost business.

Debate also rages over the virtues of single-chip versus multi-chip solutions, with "Is one chip enough?" as the nagging issue. Companies like National Semiconductor Corp. of Santa Clara, Calif., claim that the high levels of flexibility, cost control and "pick and choose" functionality, more than justify the extra board space required by multiple chip solutions. But not everyone agrees.

"The original equipment manufacturer (OEM) channel would prefer a single-chip solution, that's obvious," says Thomas Stevenson, sales and marketing vice president for Fremont, California-based graphics board maker Video Seven Inc. His company believes this so strongly that it is currently boiling down its four-chip solution into one chip, he says.

Michael Krell, graphics strategy development manager at Sunnyvale, California-based Advanced Micro Devices Inc., which has a single chip, hardwired offering, says that the type of solution is less important than its implementation. And in any case, it certainly depends on the size of the system, he explains, because the number of chips is less of an issue.

Price is another battleground, with cost cutting occurring throughout the industry, despite the fact that the hardware-based graphics market is still in its infancy. One way to keep prices up is the Intel Corp. solution, which Intel's graphics product manager, Jean-Claude Sarner, says is to offer two different chips for both low- and high-end solutions. This way, a user can remain cost competitive, and Intel can keep a share of the higher priced, high-end market.

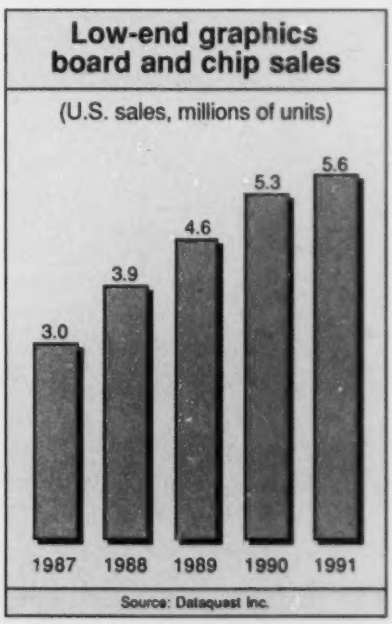
Texas Instruments Inc., headquartered in Dallas, recently reduced prices on its 34010 graphics processor by 40%; Gene Chao, president of Hillsboro, Oregon-based graphics board maker Metheus Corp., says his company is trying to push prices for high-end graphics down as close as possible to the pricing on lower-end EGA standards.

One company that is concerned with keeping prices up is Video Seven. According to marketing chief Stevenson, the board market is under intense pressure to reduce its prices. In a primarily retail market, he says, price is everything. Video Seven, however, would like to try to keep prices at a reasonable level.

More for less, please

Powering the demand for these chips are users in a number of different applications fields, all of whom are demanding more functionality at a lower price point.

For some users, flexibility is key. According to National Semiconductor's graphics marketing manager Roger Rake, his customers demand flexibility above everything else. "We try to be open for the system designer," he says. "We don't want him to feel trapped. We have many devices a designer can choose from to give him the maximum flexibility and performance in his design, and he can control the cost this way."



At Beaverton, Oregon-based instrument and graphics equipment maker Tektronix Inc., which recently introduced a graphics personal computer using TI's 34010 graphics processor, senior engineer Dave Straayer says that flexibility with his customers can count more than performance. "Graphics is an odd type of business," he says. "There are special needs and feature sets, and any product that has additional flexibility to fulfill those needs is going to be wanted. The TI part was seen as more flexible than the Hitachi or the Intel part," he says. "I was surprised that people were willing to put up with marginally less performance for more flexibility, but they were."

In addition to flexibility, users are demanding higher resolution, even for business applications, says Metheus' Chao. When Intel was designing its graphics processors, the 80276 and the 802716, flexibility and resolution were two of the most critical areas, says graphics product manager Sarner. As evidence of Intel's flexibility, users can choose exactly what functionality they require from a chip, Sarner says. For example, a user can choose between high resolution and a large number of colors.

With all this added functionality comes the question of speed. If the extra features slow down the system, it is worthless to users, says National's Rake. "A major trend in the marketplace today is higher performance graphics overall," he explains. "We hear all the time that this is a great system, but it doesn't handle graphics consistently or effectively, so the perception is that it is a slow machine. Software-based graphics are a letdown. We have to give the perception of blazing speed."

National's solution to that dilemma is to offer a number of graphics chips that can work in tandem with the main processor in order to off-load much of the work. According to Rake, this approach helps users retain their existing software and doesn't force them into choosing a new processor.

Looking forward, graphics chip designers and manufacturers see a remarkably similar future. Almost everyone agrees that, "Color is going to become far more common," as National's Rake says. "By 1988 there are going to be a large number of PCs and workstations in color."

VALERIE RICE

ATE

A little consolidation never hurt anybody

The pundits have been predicting it for years. Now it looks as if a shakeout in the ATE market is finally under way

Within one month this summer, two announcements rocked the close-knit world of automatic test equipment. In July, board test leader GenRad Inc. closed down its West Coast chip test division after absorbing years of losses. Thirty days later, Teradyne Inc. announced its intent to acquire board tester Zehntel Inc. for $75 million in stock. That move will vault Teradyne to number one in the worldwide $1.6 billion ATE market, according to San Jose market research firm Prime Data Inc.

Other potential partners are eyeing each other warily. Start-ups Semiconductor Test Solutions Inc. of Santa Clara, Calif., and Axiom Technology Corp. in Newton, Mass., share some venture capitalists, and STS president David Mees admits there might be something to gain from a match. And Steve Bisset, president of San Jose-based Megatest Corp., when asked about reputed offers from European electronics giants N.V. Philips GL and Siemens AG, hints that he might be willing to listen.

Meanwhile, with GenRad's chip-test business now gone, two-year-old whispers of a merger between GenRad and LTX Corp. are starting to circulate again. Graham Miller, president of Westwood, Massachusetts-based LTX, says that he did talk to GenRad and also looked at Zehntel a few years ago, with the idea of getting his strictly chip-testing company into the board test business. Miller evinces no interest in such activities now: "Board test is something we're not too willing to make any further investment in now."

Although GenRad says it had $27 million in sales at the high end of the component test business in 1986, competing for the crowded $325 million segment proved too expensive. The Concord, Mass., company took a $34.5 million write-off to cover the phasing out of the product line. The competition has mixed emotions.

– "It's sad in a way," says Irwin Pfister, vice president in charge of Schlumberger Ltd.'s chip test operations in San Jose. "But we've been saying it for a long time: it takes a lot of real money –- not just a percentage of revenues — to keep your performance at the edge, and only a few of us have it. It takes us over $20 million a year in R&D. That's bigger than most companies are in revenue."

Adds Frederick Bihler, president of the U.S. operations of Japanese chip tester Advantest Corp., "I'm sure it was a good decision for their company. If you can't support the effort 100%, you'd better get out of the business. The cost of developing one of those systems is horrendous."

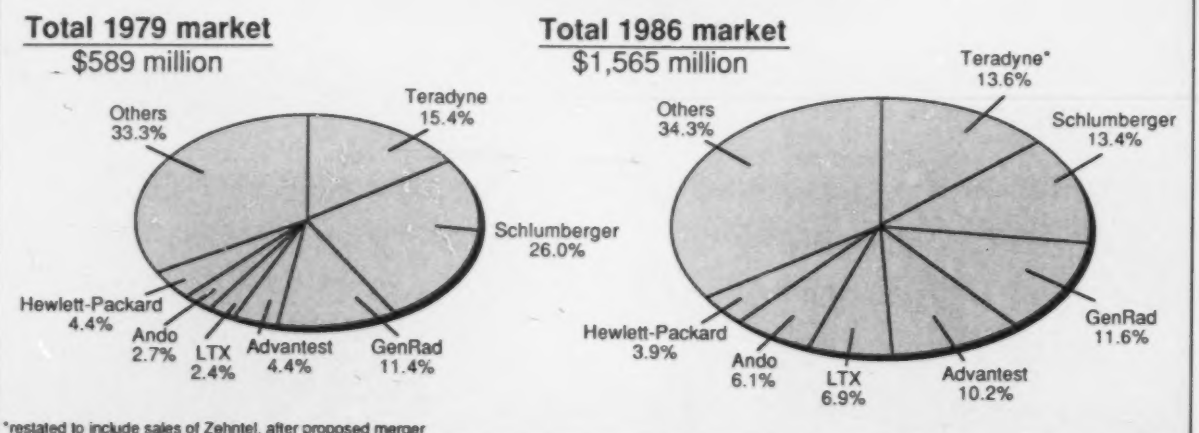
Others are extremely pragmatic. "It's great. There's a 12% market share up for grabs," says Edward Rogas, vice president of Teradyne's chip test division in Agoura Hills, Calif. "GenRad's exit doesn't make a lot of difference, but it changes the supply/demand ratio somewhat. It might affect pricing," says Megatest's Bisset. "The Delco [unit of GM Hughes Electronics Corp.] alone makes it interesting," Bisset continues. "Whoever wins it, a company like Delco represents a lot of business."

The Delco decision

Indeed, automobile-electronics giant Delco, based in Kokomo, Indiana, was one of GenRad's prime customers. Delco IC test center supervi-

ATE leaders, then and now

Worldwide sales ($ millions) and percentage of market share



*restated to include sales of Zehntel, after proposed merger

Source: Prime Data Inc.

sor John Lods claims that he isn't too upset with GenRad's exit, as his base of GenRad testers was never as big as that of his older Schlumberger line. Lods maintains that he had already started evaluating "next generation" machines. "Maybe this will speed up the process a little bit," he says, estimating that he might make a decision before the end of the year.

Does any particular ATE supplier have an inside track at Delco? "The decision now will be more clouded than it was four years ago," Lods says. "All the testers are a lot closer to being comparable now." Delco has a roomful of LTX linear testers, Lods says, but he's still a little leery of LTX's newer Trillium digital line. "I'm very, very conservative. I don't like serial numbers in the single digits," states Lods. "But Trillium has some track record on it now — even the Sentry 50 [from Schlumberger] has some track record."

Besides Delco, other plum customers left by GenRad include Advanced Micro Devices Inc. and Motorola Inc.'s microprocessor division, according to Teradyne's Rogas. The Air Force's very high-speed integrated circuit (VHSIC) contract out of Rome Air Development Center is also fair game. "There are people at the Air Force cutting their throats."

The consensus among observers is that Teradyne's proposed acquisition will allow it to make a serious run for GenRad's board tester dominance. Zehntel marketing vice president Craig Pynn says that his approximately $40 million in sales last year in the mid to low end of the board test business fit nicely with Teradyne's $70 million, mostly in the high end. GenRad marketing executive John Zapf says that the two competing companies' product lines are "complementary," but lack "synergy." He concedes that until now, "Teradyne was locked out of the low end."

Prime Data analyst Kenneth Neff's numbers show that if Teradyne's sales are restated to include those of Zehntel, there is a new leader in the overall ATE market. However, the old leader, Schlumberger ATE, cautions that not all marriages are heaven-made. "Merging cultures may be difficult. We should know," says Schlumberger's Pfister. He recalls some bumpy ground which Schlumberger traveled in acquiring the old Fairchild Camera and Instrument Corp., not to mention a deal for Accutest Corp. that was deemed by the Federal Trade Commission to conflict with anti-trust guidelines.

Irvine, Calif., board tester Computer Automation Inc. agrees that Teradyne's line is broadened, but Computer Automation president Douglas Cutsforth sees a more concrete goal in the plan. He says that Zehntel's 3200 tester has sold well to some computer companies, one Big Blue one in particular. Teradyne L200s were being replaced by Zehntel machines at IBM's Boca Raton, Fla., facility, says Cutsforth, and IBM is just the type of blue-chip customer Teradyne likes to service. Analyst Carolyn Rogers of San Francisco investment house Hambrecht & Quist Inc., says that works both ways —that Zehntel was trying to get into IBM's Austin, Texas plant, but the IBMers there thought Zehntel was too small a company to bet on.

Pynn won't comment on IBM, but does say he's had success with computer makers. "We have a good reputation but we still run into people who say, 'Zehntel's a little company — will they be there in a while to support their products?' " Pynn says. "That kind of thing will go away." Even GenRad's Zapf agrees on that. "A lot of people question a small company, but nobody questions Teradyne," he says.

So, is further industry consolidation in the cards? Some analysts have no doubt about which way ATE makers should go: "You've got to get a partner fast," says Stephen Balog of New York City brokerage firm Prudential-Bache Securities Inc. He's been forecasting a shakeout for years, which he points out is not necessarily a bad thing for the industry. "There's no shame in being the Oldsmobile division of GM," Balog says. "What you don't want to do is end up like Studebaker."

DAVID CARD

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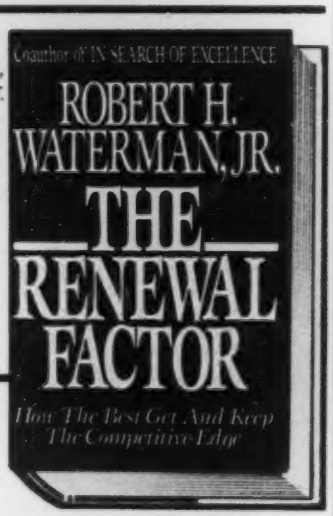


A BANTAM HARDCOVER

DISTRIBUTED PROCESSING

DBMS and the rise of generic computers

Database management systems are moving from mainframes to workstations. Software companies may reap the rewards

By Anne Knowles

Digital Equipment Corp. has made a fortune at it. Workstation makers have entrenched themselves in the industry because of it. And personal computer makers have built a billion dollar business around it.

The idea is distributed processing. Decentralize your computer power, put a piece of it at every desktop and use industry standards to communicate with one another. Hardware makers have been touting the idea for years.

But now, software makers are getting in on the act. More than machines can be distributed. Database management systems (DBMS) — the software that manages, stores and updates computer databases — have been, until recently, in the mainframe's domain. Huge and cumbersome, DBMS wouldn't fit anywhere else. And they were so complex, no one but a mainframe programmer could deal with them.

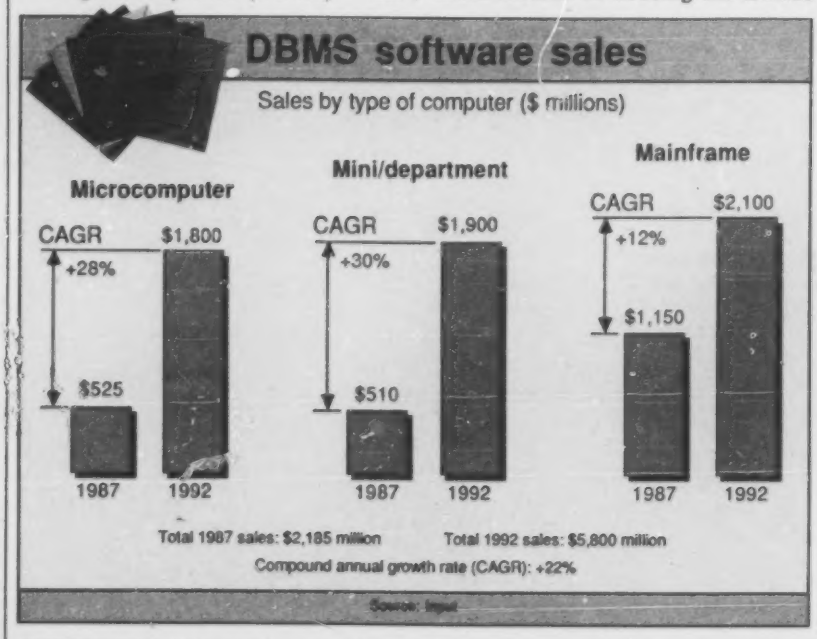
But software companies have ported DBMS to almost every hardware platform possible by centering their systems around certain standards — such as the IBM-developed Structured Query Language (SQL) and the AT&T-developed Unix operating system — and new, relational database technology.

And now they are distributing them. Instead of housing the DBMS on a central processor, software companies are splitting them up among computers of various makes and sizes in various locations. What that means for the user is faster, easier, and transparent access to information anywhere in the corporation. In manufacturing, for example, plant-floor processes can be changed, company-wide inventory can be tracked and manufacturing quality can be monitored in close to real time.

What that also means to the customer is little to no allegiance to any particular hardware platform. If databases are distributed among heterogeneous hardware platforms, and information is flowing freely between them, then, theoretically, the hardware hardly matters. And that implies the dawn of generic computing — a world in which workstations, like personal computers, are viewed as commodity products, and in which price is more important than the logo on the computer housing.

Comments Michael Cohn, an analyst with market research firm Input, in Mountain View, Calif., in his report on DBMS markets: "Based on performance improvements and the potential of the distributed/relational DBMS architecture, it is believed that off-the-shelf hardware will have no difficulty matching or surpassing the performance of proprietary hardware-based DBMS products."

Hardware makers may be concerned. While computer manufacturers may sell proprietary DBMS, it is of little value to them to promote open communication with different vendor's systems. And many observers say that the software tools — such as fourth generation languages



Just like generic goods in a supermarket, widespread use of DBMS software coupled with distributed processing, could lead to generic computers

(4GLs), natural language interfaces and optimizers which enable users to access data in the most efficient way — are what will differentiate one database product from the next.

User demand

Nevertheless, demand for workable DBMS products is running high among the original equipment manufacturing community.

"Communications issues such as MAP [Manufacturing Automation Protocol, a networking protocol proposed by General Motors] have gotten a lot of attention," says Peter Martin, manager of system product planning at process control supplier Foxboro Co. "But open information is just as critical an issue." Especially on the factory floor.

So last April, Foxboro announced its Intelligent Automation Series, a group of products aimed at the computer-integrated manufacturing market. Included in the bundle are ruggedized processors based on Intel Corp.'s 80x86 chips, instruments and a database management system.

Foxboro is providing the processors and Informix Software Inc. is supplying the DBMS. Foxboro will also add software tools. "The system will collect data across the whole plant in real time," says Martin. By the end of summer, the company claimed it had $40 million in back orders. Shipments began in October.

Foxboro chose Informix because the software company's DBMS was already well-positioned in the market, Martin says. By year-end, Informix would also have distributed DBMS capabilities. And Foxboro's customers, says Martin, wanted standards, primarily in the area of languages, which would enable them to integrate their data in a consistent way.

And other hardware manufacturers are OEMing DBMS products, based on similar criteria.

Consequently, Relational Technology Inc., an Alameda, California-based DBMS supplier, claims to have an optimizer for its Ingres software product line that can improve performance a thousand times. "It is the difference between whether a certain application is feasible or infeasible," says Bob Williams, director of product line marketing at RTI. Tools, especially those based on artificial intelligence techniques, are one more step

Gerry Baskin

away from proprietary hardware.

But technical issues – such as performance, networking and data integrity — do remain. Even companies that offer so-called distributed DBMS say they are incomplete. And human issues are surfacing. As with all new technology, it takes time for users to acquire a taste for it. "The implementation process hasn't been a fast one," says Peter Tierney, vice president at Oracle Corp., a Belmont, Calif., supplier of relational and distributed databases. "The technology is there, people want some more functions, but the fact is people don't know how to use it." Concludes Tierney: "I wouldn't want to be with a company betting their future on distributed databases."

At least not their immediate future. But within five years, estimates Input, distributed DBMS will account for about 15% of the $5.8 billion market for database management systems. Others guess higher. All observers, though, agree that by 1992 relational DBMS, which distributed DBMS are based on, will represent at least 50% of the total market. Says Richard Finkelstein, vice president with Codd and Date Consulting Group in Chicago: "Everything else [nonrelational] is dead."

"Databases, until today," says Finkelstein, "were analogous to black holes. They sucked in vast amounts of data that you couldn't do anything with." Until relational technology was developed, by E.F. Codd (of Codd and Date Consulting Group) at IBM's San Jose facility in the 1970s, all DBMS were hierarchial. Data was structured in a hierarchial order and to question it, users needed complex commands.

Relational DBMS place data in tables and establish some logical relation between pieces of data contained within those tables. And relational databases can be accessed through query languages, such as SQL, that require only a few simple commands.

Language barriers

Other query languages have been developed. QUEL, written at University of California at Berkeley at the same time Codd was working at IBM, was initially used by RTI, which was founded by the UC Berkeley researchers. But SQL has established itself, first as a de facto industry standard, due to IBM's backing, and then as an American National Standards Institute standard.

Ironically, though, IBM was not the first to implement SQL or relational technology. RTI was the first to offer a relational DBMS and Oracle, in 1979, was the first to bring out a system based on SQL. IBM, on the other hand, waited untill 1983 to announce DB2, its relational SQL DBMS for its mainframe systems.

IBM also has not incorporated distributed functions into its DBMS offering though the company is reportedly ready with a commercial product which evolved from its distributed DBMS research effort, called R*Project, in San Jose.

While SQL makes it easier for users, it is a barrier to suppliers. It is not an easy standard to follow. Codd and Date's Finkelstein estimates that there are only a dozen people capable of writing SQL engines for DBMS. Otherwise, says Finkelstein, it takes three years to develop. So, companies are acquiring it, one way or another.

SQL, though, is not prerequisite for participation in the PC DBMS market, says Randy Sutherland, an analyst with Dataquest Inc. SQL is vital for networked databases. But many PC database systems, says Sutherland, are used as standalone systems. They are limited by the amount of memory within a PC operating system but fully relational DBMS, such as Ashton-Tate's dBase products, run on microcomputers.

That is fortunate for PC DBMS vendors that now have IBM to compete with. IBM's extended version of OS/2, the new operating system for its PS/2 line of microcomputers, will have a SQL-based DBMS embedded within the operating system. That may lock up the *Fortune* 500 market for IBM, says Sutherland.

But opportunities for third party vendors, says Sutherland, still exist in the standalone PC market. And

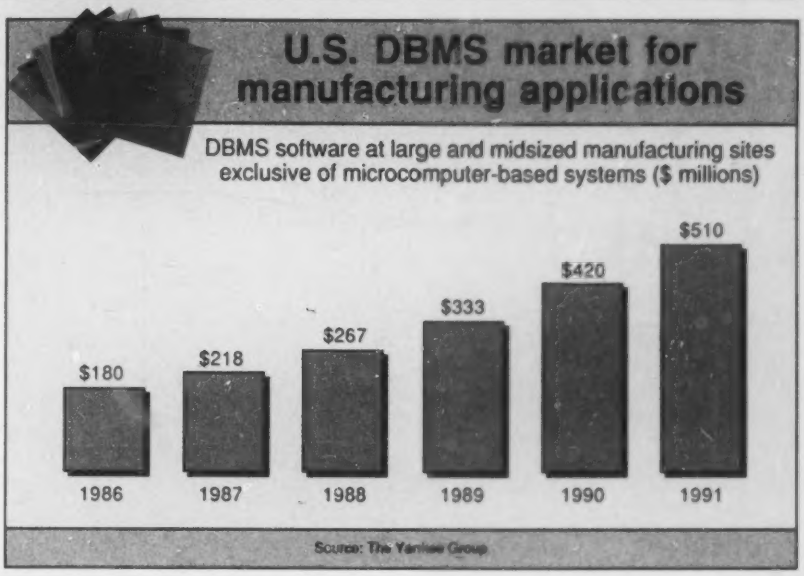
SYBASE PRESIDENT HOFFMAN catches Apple's eye, and investment, with Sybase's distributed DBMS.

Liane Enkelis

also within the still-vital market for MS/DOS — the standard operating system currently running on IBM PCs and compatibles. In fact, Microsoft Corp., developer of both MS/DOS and OS/2, is expected to enter the PC DBMS market within the year, as is Lotus Development Corp., developer of the Lotus 1-2-3 spreadsheet application package. And the DBMS market for non-networked PCs running the first version of OS/2, sans an embedded DBMS, will be left up for grabs. Says Sutherland: "The third party vendors will have to duke it out for the rest."

IBM isn't the only PC maker with databases on its mind. Apple Computer Inc. recently made an estimated $1 million investment in Sybase Inc., a Berkeley, Calif., supplier of distributed relational DBMS for Sun Microsystems Inc.'s Unix-like operating system and DEC's VMS. Sybase is expected to provide Apple with a DBMS for the micro makers as yet unannounced version of Unix. Says Mark Hoffman, Sybase president: "Unix is the most logical way to go."

Sybase has plans to announce compatibility with IBM's DB2 mainframe DBMS, allowing any Sybase-developed DBMS for Apple to be linked to a corporate mainframe running DB2. Currently, Apple's Hypercard product, which was announced at the MacWorld trade show this summer, contains a DBMS. Dataquest's Sutherland says it is not a full-blown relational database system but it is a "powerful database considered part of the operating system." If all the pieces fall into place for Apple soon, says Sutherland, "it is conceivable Mac users will have exactly what IBM users have only been promised."



But IBM has, at the least, made its intentions clear. DB2 successfully staved off the success of third party vendors in the mainframe DBMS market. Mainframe DBMS vendor Cullinet Software Inc., for example, has been losing money for the past year and a half and has since plunged itself into the midrange computer software market. IBM's dominance in the mainframe DBMS market is ir-

The need for new guidelines

After E.F. Codd developed relational database management systems at IBM in the 1970s, and companies started announcing relational products, the marketplace was engulfed in confusion. Some vendors provided certain functions, and others did not. So, Codd developed a list of the 12 principles behind relational technology.

Today, all relational DBMS are judged by it.

Soon, Codd — now of Codd and Date Consulting Group in San Jose — is expected to release a similar list for distributed database technology. None too soon. Now that independent software vendors and hardware manufacturers alike are marketing so-called distributed DBMS, chaos has hit again.

No such set of guidelines exist today. But most experts agree upon certain minimal functions that a relational DBMS must have in order to distribute it.

First, is referential integrity. Richard Finkelstein, a vice president with Codd and Date, says it is one of the principles of relational technology that no vendor, to date, has incorporated into a DBMS. It involves how data is arranged within a database. Data in a relational DBMS is laid out in tables with cells similar in appearance to spreadsheets. For each table there is a primary key, a domain, and a foreign key. The combination of those three components allow tables to be cross-referenced.

Another issue is how the database is distributed. Are entire versions of the database replicated on each system in the network? Are they partitioned into mutually exclusive subsets, with no replication? Or is it a hybrid solution, where data that is vital to one location, but not to another, is partitioned to that processor, and common data, shared by all nodes on the system, is replicated at each processor?

Updates are another problem. Data must be accurate at all sites. If information is changed, or added or extracted, on one node, all the other nodes must reflect that. Two-phase commit, offered only by Sybase Inc. to date, also has to occur. If, for example, a bank customer transfers money from one account into another — debiting and crediting within the same transaction — the DBMS must be sure that both phases of the transaction have been completed.

Some say performance is an issue. Relational technology pays a penalty in performance in exchange for ease-of-use. Distributed DBMS rely on other technologies — such as networking — that are still advancing. And the further that artificial intelligence techniques progress, the more willing the user will be to distribute a database. □

refutable; last year, IBM's DB2 and IMS DBMS accounted for about 40% of the IBM-compatible mainframe database systems market.

"IBM knows that whoever owns the corporate database," says Codd and Date's Finkelstein, "owns the corporation."

Midrange melee

That may depend upon how one envisions the corporation — as a plethora of PCs networked to a centralized mainframe or as a network of workstations, PCs and departmental systems.

In the relational and distributed DBMS market, most of the action has centered around the midrange. Much of the innovation has occurred there; Oracle, RTI, Tandem Computers Inc. and Sybase are the handful of companies offering distributed DBMS today. Other midrange players, such as Menlo Park, California-based Informix Software Inc. and Lake Oswego, Oregon-based Unify Corp., plan to announce distributed DBMS by year-end.

Their collective genesis was in the midrange. For RTI, it was in the DEC VMS market. Oracle started by porting its DBMS to Unix. All of these companies have also migrated downward, into the PC arena, by porting their systems to MS/DOS. And they offer DB2 compatibility. "If someone has DB2 and is committed to it," says RTI's president, Paul Newton, "we don't tell them to throw it out." Concludes Newton: "We'll never blast IBM out of the DB2 environment."

RTI'S PRESIDENT NEWTON: "DEC has expanded into corporate America over the last few years. We'll ride on their coattails."

Mainframe DBMS vendors can understand that. The midrange software companies with their minicomputer-oriented offerings are growing while some mainframe third party DBMS vendors have stagnated. Oracle, which has been public for over a year, increased its sales 136% last year, to $131 million, while its net income rose 170%, to $15.9 million. Informix's revenue has doubled each year for the past four years. RTI added 700 customers to its list last year and is recording 80% sales growth annually, according to company president Newton. But that would put the privately held company somewhere in the $50 million revenue range, up 80% from its own reported $28.1 million in sales in 1986. That is less than half of Oracle's sales.

The rivalry between the two companies is well known. Peter Tierney was vice president for marketing at RTI until this past January when he

A view from the top of the Pyramid

It's clear today that DBMS is one software issue that hardware makers can't ignore.

"It isn't the hardware that is so important anymore," says Richard Rebh, director of applications marketing at superminicomputer maker Pyramid Technology Corp. "It is the integrated hardware and software."

"Database software is as critical as systems software is to us now," says Rebh. While DBMS vendors have been busy porting their systems to many hardware architectures, Pyramid has been busy signing deals with DBMS suppliers. There are now between 16 and 18 databases available on the supermini makers' hardware, says Rebh. And now the company is forging into the on-line transaction processing market with a new line of processors, based on the company's Series 9000 superminis and Sybase Inc.'s distributed relational DBMS. The new systems are called R*tp.

"Sybase in the only product that will take Pyramid into on-line transaction processing," says Rebh. "Sybase has leading edge product. And there are no performance penalties."

Sybase is now part of an ambitious plan, on Pyramid's part, to provide DBMS for its hardware. The push to provide databases started in February, when Pyramid launched an official DBMS program. The program is divided into three categories. Prism products is a customer catalog of third party DBMS available for Pyramid. Pyramid Partners is a value-added reseller program in which Pyramid resells and supports third party DBMS products. Pyramid Products is a classic original equipment manufacturer relationship between the hardware company and software vendors in which Pyramid sells DBMS under the Pyramid label.

Informix, Oracle, RTI and Sybase have all been signed up since February. Sybase's distributed relational DBMS is a Pyramid Product. And Informix, Oracle and RTI are all Pyramid Partners. Says Rebh: "We're supporting RTI for technical users, Oracle for commercial users, and Informix for smaller applications." □

Liane Enkelis

joined Oracle. RTI claims to have had the first commercial distributed DBMS system on the market, with installations in two dozen major corporations. Oracle's Tierney claims RTI's Ingres/Star is only installed as production units. "Just ask RTI," says Tierney. RTI's Newton counters that other distributed DBMS on the market "are just toys." The debate goes on.

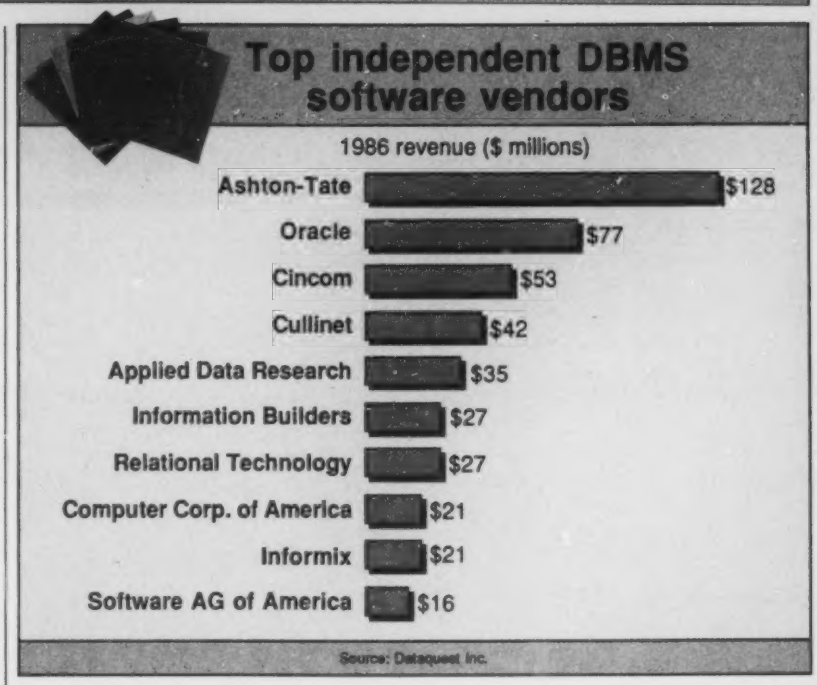
RTI became famous in the industry as a scientific and engineering DBMS vendor because of its origins in academia and its early adoption of DEC's VMS operating system. Since then, though, the company has adapted its Ingres DBMS to IBM's VM operating system, MS/DOS and about 25 different hardware platforms running some flavor of Unix. And now it is poised to follow DEC into the *Fortune* 1,000. "DEC has expanded into corporate America over the last few years," says RTI's Newton. "We will follow on their coattails."

Oracle, on the other hand, has always been recognized as a commercial DBMS vendor. Among its OEM customers Oracle claims AT&T, Prime Computer Inc., Wang Laboratories Inc. and Xerox Corp. And, of course, IBM. Big Blue has marketing rights to Oracle for its RT PC, engineering workstation, and its System/88 fault-tolerant system which it buys from Stratus Computer Inc.

RTI has a much-coveted deal with DEC. DEC resells Ingres for its Unix-like Ultrix operating system. Informix can claim Tandem Computers Inc., a hardware maker in the on-line transaction processing market that relies on DBMS for its bread and butter. Tandem resells Informix's Unix-based DBMS for its customers using LXN, Tandem's Unix-like operating system.

But the companies' customer lists also intersect and overlap. All three companies can claim AT&T, IBM and General Motors Corp. among their buyers.

For a relatively late entrant, Sybase is already "a well-connected company," says Input's Cohn. In addition to its investment from Apple, the Berkeley-based start-up has an OEM arrangement with Pyramid Technology Corp., and reportedly with Stratus. Sybase started shipping product last April. The deal with Stratus, says Hoffman, is for "exploration of joint technology." So far, the company has ported its system to DEC's VMS and Sun's Unix.



Sybase is taking a different approach than most midrange DBMS vendors. While Informix, Oracle and RTI have ported their DBMS to literally hundreds of hardware platforms, Sybase's Hoffman says Sybase plans to limit itself to only a handful. In addition to VMS and Sun's Unix, Hoffman says, Apple's Unix, IBM's VM operating system for its 9370 midrange computer, MS/DOS and OS/2, are among the other strategic platforms Sybase plans to utilize.

Most advanced DBMS

Sybase also has, by many accounts, the most advanced distributed DBMS offering. The company has incorporated what is called "two-phase commit," within its relational DBMS. Two-phase commit — a necessary function for a truly distributed DBMS — guarantees that two, or more, interdependent transactions will not occur individually unless both occur. A banking transaction, for example, may involve debiting one account in order to credit another account. Two-phase commit ensures that either both the withdrawal and deposit happen, or nothing happens at all.

That puts Sybase square in the market for on-line transaction processing. Hoffman says that is the market Sybase is zeroing in on, albeit a huge one; OLTP is expected to become a $35 billion market by 1990, estimates Dataquest. The deal with Stratus — a maker of fault tolerant computers — in particular, pegs Sybase for the OLTP market.

It also pits the company, indirectly, against Tandem Computers. Tandem, both a hardware and software supplier, values its DBMS business as much as most computer vendors cherish their systems software sales. It was one of the first companies to offer a distributed DBMS, according to Frank Cluggage, Tandem's SQL product manager. In the mid-1970s, Tandem started selling its Encompass line of DBMS software and tools. And this past year it introduced NonStop SQL, a SQL-based relational DBMS for its series of NonStop processors. But Tandem's is a proprietary DBMS system, sold for Tandem systems alone.

For other hardware vendors, says Input's Cohn, that is the dilemma. DEC, IBM and others have to live in a multivendor environment. But they want to offer one solution. Third party DBMS vendors, on the other hand, exist because of the multivendor, multisolution environment. And companies like Informix, Oracle and RTI depend upon computer manufacturers for sales; generally 50% of their revenue is generated by OEM, value-added reseller and joint marketing agreements. Says Cohn: "They have to make strategic alliances with hardware manufacturers. But they can't get too close to any one vendor." □

Signs of a recovery

The computer, peripherals and related equipment market is showing signs of recovery. New orders were up 2.7% in July from the same month a year ago to stand at $4.0 billion. Aggregating the first seven months of the year, bookings were running 5.8% above the comparable period for last year. Shipments were showing encouraging signs too, with July shipments increasing 3.9% compared to July 1986. Although total shipments through the midsummer months were trailing the period for last year by seven-tenths of a percent, a brisk second half is expected. Backlogs, at $19.2 billion on a seasonally-adjusted basis, were at their highest level since the end of 1985.

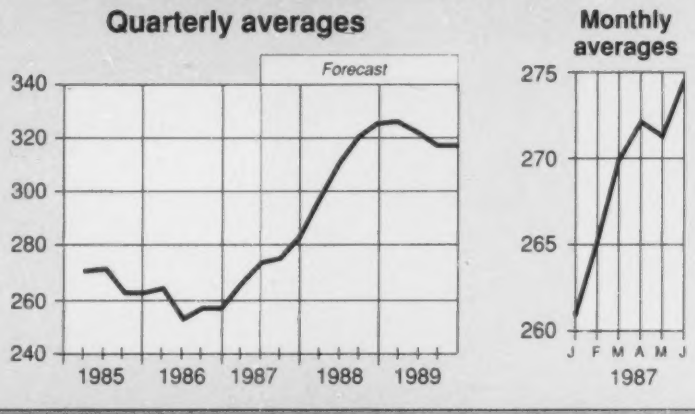
Computer manufacturers were keeping a watchful eye on inventory levels. Value of inventory in July was 8.5% below its year-ago figure. With the tight control on inventory and the slow increase in shipments, the inventory-to-shipments ratio stood at only 1.96, well below the 2.90 average in 1981.

Total employment jumped 0.8% in June to 457 million, a gain of 3.5 million jobs. This gain was reassuring since in May computer employment was at its lowest level since April of 1981. With a computer recovery now underway, employment growth should continue through next year.

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158 Phone: (617) 964-3030.

Industrial production of computers

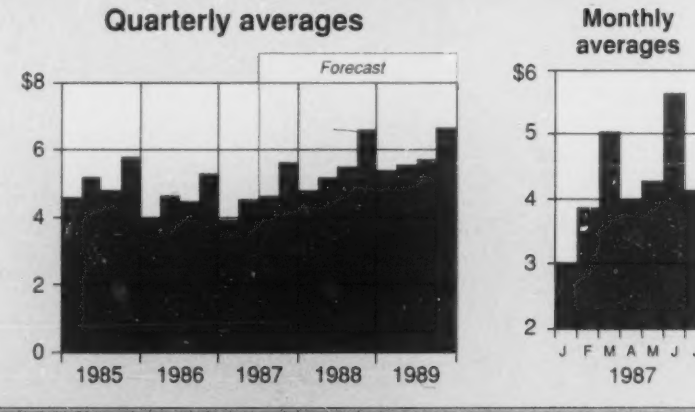
Seasonally adjusted index (1977=100)



Source: Federal Reserve Board; Forecast: Cahners Economics

Shipments of computers

($ billions)



Source: U.S. Bureau of the Census; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA, 1977=100, June)	274.6	271.0	+1.3%	250.7	+9.5%	309.0	+12.5%
Shipments ($ millions, July)	$4,143	$5,640	-26.5%	$3,987	+3.9%	$5,284	+27.5%
Orders ($ millions, July)	$4,009	$5,746	-30.2%	$3,905	+2.7%	$6,396	+59.5%
Unfilled orders ($ millions, July)	$19,512	$19,646	-0.7%	$19,528	-0.1%	$21,661	+11.0%
Inventory-to-shipments ratio (SA, July)	1.96	2.10	—	2.20	—	2.07	—
All employees (millions, June)	457.2	453.7	+0.8%	479.3	-4.6%	491.3	+7.5%
Production workers (millions, June)	149.2	147.6	+1.1%	162.3	-8.1%	163.4	+9.5%
Exports ($ millions, June)	$1,574	$1,386	+13.6%	$1,224	+28.6%	$1,573	0.0%
Imports ($ millions, June)	$1,587	$1,519	+4.4%	$1,260	+26.0%	$1,694	+6.7%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

PASSIVE COMPONENTS

The capacitor makers who are anything but passive

The downturn taught capacitor makers a trick or two. These days, specialized products are the name of their game

By Michael R. Leibowitz

If you want lessons on what to do when your commodity market collapses, turn to the capacitor business. Executives in the $2.2 billion domestic capacitor industry can tell you how to buy out your company from its disillusioned conglomerate parents; give you tips on selling and buying ailing product lines; and pass on other strategies for staying in a business where prospects for high growth have long since faded. In the midst of industry-wide consolidation, U.S. capacitor makers have become experts on these painful topics.

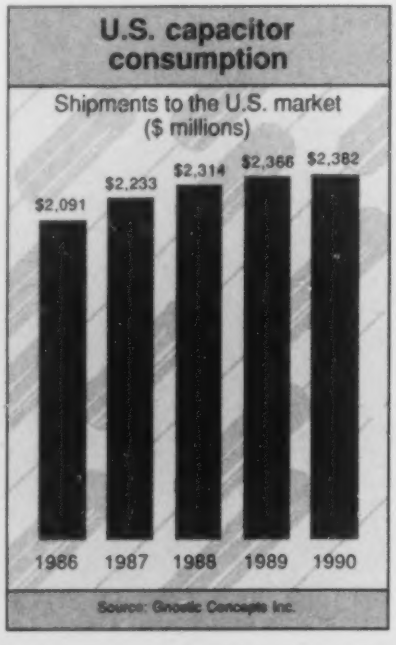
Like other component suppliers, capacitor makers found themselves severely buffeted by the mid-1980s downturn in the electronics industry. A major restructuring occurred as parent companies, unwilling to pour in the capital needed, shed some or all of their capacitor operations. Penn Central Corp. spun out the No. 1 U.S. capacitor maker, Sprague Electric Co., as a public company earlier this year. Management purchased Cornell-Dublier Electronics Inc. from parent Exxon Corp. at the beginning of the downturn. Mallory Capacitor, a division of Emhart Industries Inc., sold its aluminum electrolytic line to RTE Corp.

The upheaval is not over yet. "I think there's some further shakeout in this industry," says Steven Murray, president of Mallory Capacitor of Indianapolis, Ind. "I still believe there's too much capacity."

But while the capacitor shakeout may be far from complete, the bulk of the restructuring activities at some of the larger capacitor makers has already occurred. The industry is also enjoying some modest, but long awaited, growth. Gnostic Concepts Inc., a San Mateo, Calif., market research firm, estimates that 1987 sales of around $2.2 billion were up 7% over last year, and that 1988 industry sales will show 4% growth over this year. With some semblance of stability returning to the capacitor industry, the major players are busy implementing their strategies for survival in their chosen market segments.

Product pruning

By far, the most significant strategy for survival by capacitor makers has been a selective pruning of certain product lines and a build up of others. Manufacturers have been forced to make a hard assessment of which markets they can remain strong in and which are likely to be losing propositions.



Mallory Capacitor, in selling its electrolytic-capacitor line and placing its solid tantalum line on the block, had cut its workforce in half. "These lines were losing money and just didn't fit the strategic objectives of this company," says Mallory president Murray.

Today, Mallory has aligned itself with two capacitor businesses: DC film capacitors and wet tantalum capacitors. Mallory believes it can hold a favored position in both lines. "Our technology is good, our patent position is good, and the product lines have been profitable in the past," says Murray. "We're going to spend money on [these lines]. We intend to be the leader in those product lines that we're going to stay in."

Despite the narrowing of its product range, Mallory intends to continue to offer a broad range of capacitors to its distributors. Mallory will purchase the capacitors it does not manufacture from other makers for resale through its distribution network.

Cornell-Dublier means to stay in the aluminum electrolytic capacitor business. The firm, headquartered in Wayne, N.J., bought an aluminum electrolytic line — as well as a mica capacitor line — from Schlumberger Ltd.'s Sangamo Weston division last May. "No, the markets are not in that rapid a growth situation," acknowledges Edwin Read, senior vice president for Cornell-Dublier. "The at-

tractiveness was that Cornell-Dublier is also in those two product lines. We saw the opportunity to consolidate and expand our total manufacturing capability in electrolytic and mica."

The acquisition of Sangamo Weston's mica line, for example, will help Cornell-Dublier compete against capacitor makers from Japan and India that Read claims have been making inroads into the domestic market. "The acquisition was part of our strategy to increase market share," says Read. The same tactics apply to the company's aluminum electrolytic business.

As more electronic equipment manufacturers shift to surface mounting of electronic components, surface-mounted capacitor "chips" have become a fast-growing product area. AVX Corp. of Great Neck, N.Y., got into the tantalum chip business through the acquisition of STC Ltd.'s tantalum capacitor operation in 1986. "We bought that because we see a surge in the surface mount area in tantalum," says Marshall D. Butler, AVX's chairman. "We feel that STC had the best-designed tantalum chip."

Not all capacitor makers are using acquisitions to diversify. Kemet Electronics Corp. of Greenville, S.C., also has broadened its surface-mount product lines, but has chosen to build, rather than buy. Kemet, which president David Maguire claims maintained profitability throughout the downturn, invested $25 million in 1985 to build a world-class surface-mount ceramic chip capacitor plant. "We've been chip limited ever since we've been in the business," says Maguire. "Now we can participate in all of the [ceramic] market."

Kemet also plans to expand its product offerings into the market for molded tantalum chips; the company began tooling up to produce these parts in 1986. However, president Maguire concedes that his firm "has a long ways to go."

ASIC-type capacitors

Capacitor makers are also beginning to follow the niche or application-specific strategy recently popularized by the semiconductor industry. By focusing on smaller-volume, specialized capacitor types, vendors believe they can distance themselves from some of the vagaries of the commodity market.

"We have a host of new, application-specific products coming forth," says AVX's Butler. One example is a multilayer ceramic (MLC) capacitor that replaces larger electrolytic capacitors used in power supplies. "We can lower the weight of power supplies by 25% to 35% by using an MLC instead of a regular electrolytic," adds Butler.

Another application-specific product from AVX is an array of capacitors on a single ceramic substrate, designed to fit on the pins of a cylindrical or D-subminiature connector. This array is sold to connector manufacturers and converts the connector into a filter.

AVX sees its emphasis on application-specific products as the way to continue outpacing the market as a whole. According to Butler, application-specific products will bring AVX 25% of its sales five years from now. Today, these products represent only 10% of the company's revenue.

Reducing manufacturing costs while maintaining high quality is an immediate priority

Sprague, headquartered in Lexington, Mass., is another manufacturer targeting the specialty capacitor market. "We will start to see a dramatic change in passive components, which have been somewhat lagging relative to the semiconductor industry," remarks Peter Loconto, Sprague's senior vice president for sales and marketing.

Sprague has built a new plant to produce ceramic multilithic capacitors, which are parts that contain many isolated capacitors on a single substrate. The product can accommodate 100 or more isolated capacitors on a single substrate, depending on their size. "We feel that it's the next generation in packaging concepts," says Loconto.

For Cornell-Dublier, application-specific products are "basically the thrust of our new product development, rather than looking for large-volume markets which we probably don't do as well in as some of our offshore competitors," says Cornell-Dublier's Read. Cornell-Dublier's first application-specific products — thin-film capacitors optimized for use in electromagnetic interference filters — will be introduced within the next six months. "Within five years we'd like to have at least half our business in application-specific products," says Read.

Cutting production costs

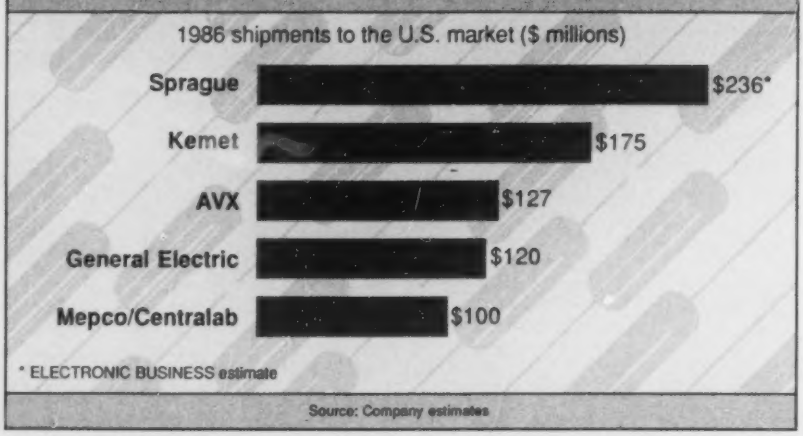
But for all capacitor makers, reducing manufacturing costs while maintaining high quality is an immediate priority. Competition in the industry remains stiff, and major capacitor customers continue to pare down their vendor lists.

Corning Components Inc., a Biddeford, Maine, division of Corning Glass, has lowered the cost of its ceramic capacitors by 15% by developing a method for producing them without using palladium, a precious metal which sells for $130 an ounce. Almost all of his competitors' parts still use either palladium or a palladium-silver alloy, claims Robert Yard, Corning's marketing manager.

In making AC film capacitors, Cornell-Dublier has eliminated its dependence on outside suppliers of metallized films, which have fallen into short supply worldwide, according to Cornell-Dublier's Read. The company produces its own metallized paper electrode in its fully-integrated capacitor plant in New Bedford, Mass.

Since becoming a private company three years ago, Cornell-Dublier has invested between 20% and 25% more

The top five U.S. capacitor makers



in capital equipment to streamline manufacturing. It has also acted to reduce costs by moving the high volume portion of its film capacitor manufacturing from the United States to its plant in Taiwan. "We're positioning ourselves to be able to [offer] more competitive pricing," says Read.

AVX is busy increasing its production capacity in surface-mounted MLC capacitors. According to chairman Butler, Japanese capacitor makers have gotten a head start in manufacturing surface-mounted components as suppliers of capacitor chips to high-volume consumer electronics markets. Now the big challenge for U.S. capacitor makers is to increase chip capacitor production and reduce costs, says Butler.

Butler boasts that AVX has made huge strides in improving the way it handles chip capacitors. "Now it's just a matter of increasing our volume — increasing our ability to test and making the yields as high in surface mount as they are in leaded devices," he explains.

In addition to investing to keep foreign competition at bay, AVX has discovered a way to grab a share of the lucrative Japanese market. Its joint venture with ROHM Corp. of Japan gives AVX 25% of a Japanese MLC capacitor company that has become the fourth-largest MLC vendor in Japan, according to AVX's Butler. Citing a broadening of his company's geographic base as a key strategy for growth, he boasts: "We're starting to do a good job in the Far East." □

Mepco/Centralab plans to outpace others

To hear the company's president talk about it, one would think the Mepco/Centralab Inc. was in the proverbial eye of the hurricane. The hurricane, of course, being the stormy state of the capacitor industry where mergers, divestitures and management buy-outs have been occurring with frightening frequency.

According to president Steven Karlik Jr., those tumultuous times are ancient history for Mepco/Centralab, a North American Philips Corp. subsidiary located in Riviera Beach, Fla. Nearly two years ago, N.A. Philips merged its Mepco and Centralab passive component operations into one corporation. (Mepco itself was a conglomerate of several companies.) Consequently, today the company is much more stable than most of its competitors, asserts Karlik. The Philips offshoot is also running leaner, thanks to the slashing of duplicate overhead. The salesforce, for one thing, has been consolidated into one cohesive national network.

Also, the company closed its operations in Milwaukee; Morristown, N.J.; and Mexico. "In the consolidation, we ended up with about one-half the corporate staff we had, so certainly there was a cost saving," says Karlik. He asserts that the restructuring is now more than 95% complete, and that his company is done with divesting. If anything, he adds, Mepco/Centralab is in the acquisition mode. Indeed, N.A. Philips announced last June that it was folding its Ohmite resistor subsidiary into Mepco/Centralab. "Now," says Karlik, "all of the passive component operations inside of N.A. Philips come under the Mepco/Centralab corporation." In addition, Karlik does not rule out the possibility of buying an outside company.

MEPCO/CENTRALAB's KARLIK: "We're probably the biggest investor in the passive component area today"

Drastic cost slashing

Even though Mepco/Centralab underwent drastic cost slashing last year, the company did not become investment stingy, asserts Karlik. He claims that the firm will spend more than $20 million this year on R&D and capital equipment; more than 75% of the money is being spent on surface mount technology. "We're probably the biggest investor in the passive component area today," asserts Karlik. "With many of our competitors' businesses up for sale, we've had a chance to look at them in order to be able to bid on them; we've seen the capital investments they've been making . . . and it's nowhere near the dollars we're talking about."

Indeed, Dutch parent N.V. Philips seems committed to the passive component business. Or at least to N.A. Philips. This fall, N.V. Philips was trying to buy back the outstanding shares of its U.S. subsidiary, in which it held a 58% interest. Robert L. Renck Jr., managing partner of New York City investment analysts Renck Levy & Company Inc., says the move was wise. He notes that previously, "Philips was fighting with one hand tied behind its back."

Having such a protective parent helps Mepco/Centralab compete vis-à-vis the company's competitors, many of which have been abandoned by their respective parent corporations, claims Karlik. "The profits weren't there for them," he says, "and they didn't want to make the investments that were needed to upgrade the quality of their technology."

Consequently, Karlik asserts that Mepco/Centralab will outpace the market this year. In fact, he is counting on a 1987 sales growth in excess of 20%. "People who see our factories and see the investments we're making realize that we wouldn't be making them if we weren't here for the long pull . . .. Philips is in the component business to stay."

But whether all this will translate into a stronger market position for Mepco/Centralab is uncertain. "Centralab is by no means a leader in this business," claims Robert Gutenstein, director of research for Kalb, Voorhis & Co. of New York City. "They've put a lot of money into surface mount technology, but when I talk to customers, I just don't hear their name very often. I hear Sprague, Kemet and AVX more." Indeed, AVX is also planning for sales growth in excess of 20% this year. Admits Karlik: "We still have a ways to go to get the Mepco/Centralab name on the tip of the user's tongue."

ALDEN M. HAYASHI

ARTIFICIAL INTELLIGENCE

Expert systems on the factory floor

Most AI R&D is going on behind closed doors. But progress is being made, experts on expert systems say

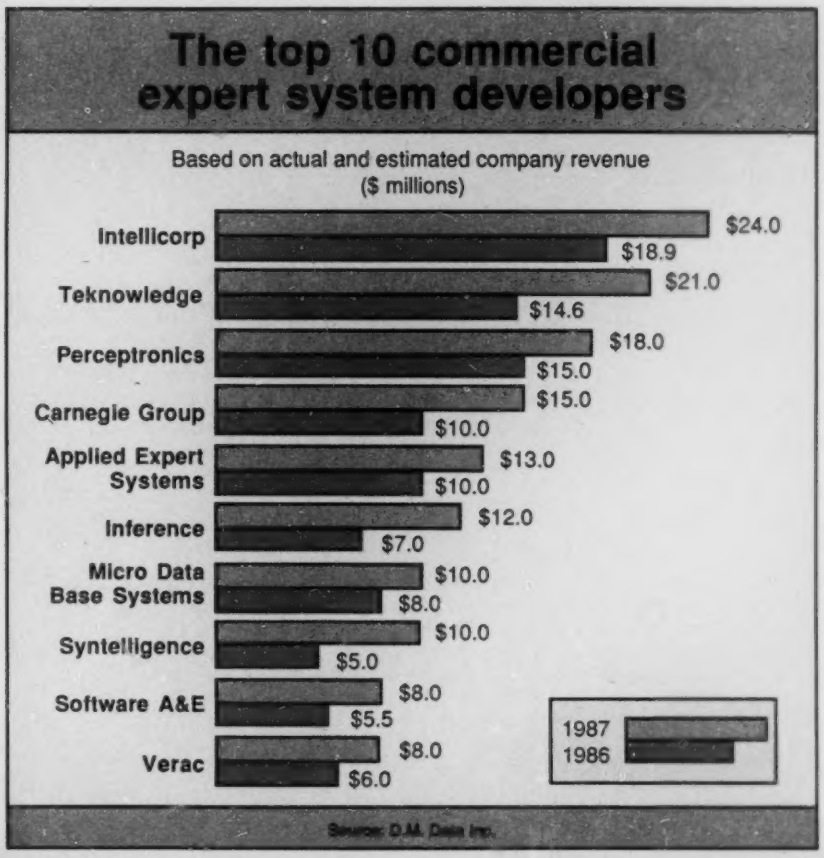
By Mary Jo Foley

Expert systems — software that enables computers to reason like humans — is the most common form of artificial intelligence, but most of the development work is taking place behind closed doors in *Fortune* 500 companies. Much of the work is occurring at electronics factories and is focused on finding applications in the manufacturing environment.

Paul Harmon of the San Francisco-based consultancy, Harmon & Associates, estimates that there are already 1,000 manufacturing expert systems under development at electronics and other U.S. corporations. Existing applications range from growing gallium arsenide crystals for semiconductor production, to repairing and configuring electronic equipment.

Relatively few of these systems, however, are expected to become commercial products; those which do are much more likely to be embedded in existing hardware and software offerings than sold as off-the-shelf packages.

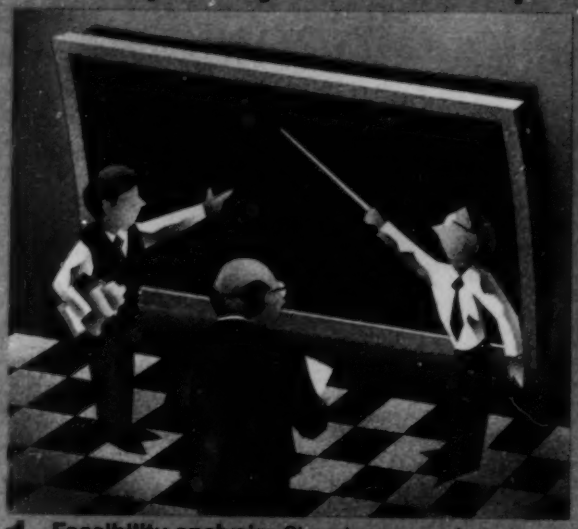
Instead, the vast majority of manufacturing-oriented expert systems will be used internally by companies to achieve and maintain competitive advantages in their respective businesses. In terms of tangible benefits, expert systems for manufacturing "create opportunities for increased productivity, reduced costs [as a result of less machine down-time], shortened design cycles, improved utilization of people assets, and improved [product] quality," explains Mark Linesch, product marketing manager for AI software within Texas Instruments Inc.'s Data Systems Group. Ultimately, industry gurus say, manufacturing expert systems could prove to be the glue which will bind the individual automated manufacturing processes that comprise the computer-integrated manufacturing factories of the future.



THE MARKET

Most credit the General Program Solver — a program designed to prove the validity of Principia Mathematica, the early 20th century propositional calculus system, which two Carnegie-Mellon University researchers devised in the late 1950s — as the first expert system effort. The developers demonstrated a working prototype at the now-famous

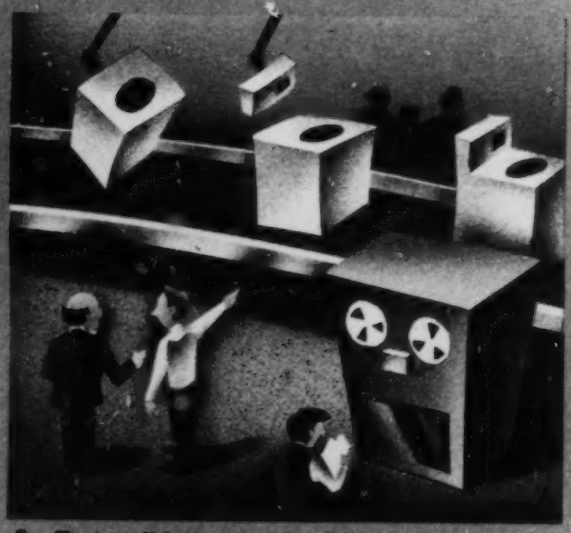
The expert system development cycle



1. Feasibility analysis: Choosing a manufacturing problem to which expert system technology is applicable and provides the best solution is the most crucial issue in expert system design.

2. Knowledge acquisition and engineering: Extracting information from various sources (including human experts) and inputting it into the expert system can be a long and involved process.

3. Prototype development: Making additions, changes and deletions to the various pieces of the expert system is key to honing its problem-solving capabilities.



4. Test, validation and implementation: Integrating the expert system with other manufacturing hardware and software is probably the most difficult step in the expert system development process.

Dartmouth Conference, held at Dartmouth College in Hanover, N.H., in 1956. Following the conference, several researchers honed their expert system knowledge by developing systems which played championship-level chess and checkers. One of the first, if not *the* first, true expert system success stories came into being shortly thereafter: Stanford University Professor Edward Feigenbaum's Dendral, a system for analyzing chemical compounds.

Today, according to the Scottsdale, Ariz., AI market research firm, D.M. Data Inc., expert systems represent one of the largest segments of the AI market. Of the $1.43 billion spent in 1987 on AI development in the United States, D.M. Data projects that $225 million, or 16% of the total, is attributable to expert systems this year. By 1990, when the total market reaches $4.05 billion, the expert system portion will reach $810 million, or 20% of the total, claims analyst Harvey Newquist.

But, because these estimates reflect commercial sales of AI hardware and software, they do not take into account most of the substantial in-house investments companies are making in AI. For this reason, it is difficult, if not impossible, to make estimates of the true size of the expert system world.

Most industry watchers do agree, however, that the lion's share of activity in most AI segments — expert systems included — still is defense-related. One such analyst, Peter O'Farrell of Arlington, Massachu-

Dave Joy

TI's MARK LINESCH: Expert systems for manufacturing "create opportunities for increased productivity"

setts-based Cutter Information Corp., claims the defense portion of the expert system market represents two-thirds to three-fourths of the total investment. Of the remaining portion, the manufacturing expert system segment is the largest, comprising about 12% to 15% of the "commercial" expert system world, O'Farrell says. The second largest commercial area is financial/banking, at 8% to 10%, he estimates.

"This year, things probably will be slowing down a little. It's time for contemplation and absorption of existing technology," says O'Farrell, who also is coauthor of a recent Cutter study entitled "Expert Systems in Manufacturing."

Nonetheless, operational expert systems for manufacturing abound and should continue to proliferate. The first such systems evolved as joint projects between top universities and their neighboring high-tech companies, such as the Massachusetts Institute of Technology and Digital Equipment Corp.; and Carnegie-Mellon University and Westinghouse Electric Corp. Some expert systems for manufacturing, such as DEC's XCON, a program which configures all DEC computers, have achieved legendary status in the worldwide AI community. Others, such as AT&T's switch-failure detector, which is being developed by engineers at its Oklahoma City 5ESS switch manufacturing facility, are relatively unknown.

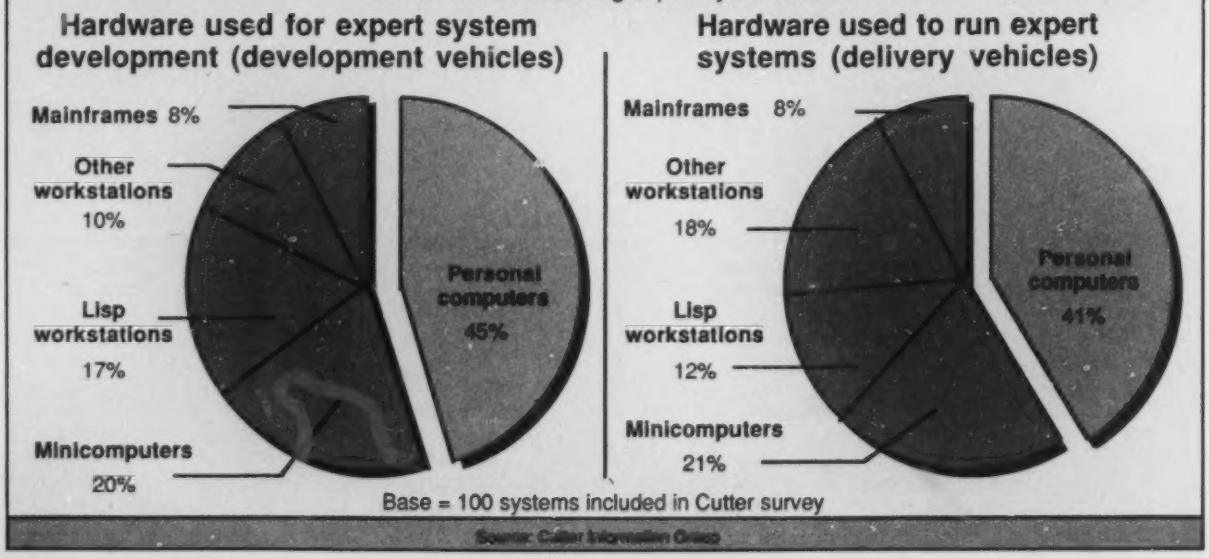
Despite their wide-ranging applications, some commonalities do exist among expert systems for manufacturing. Like more traditional manufacturing software, expert systems for manufacturing tend to be modular in design — meaning they are comprised of interlocking individual modules, as opposed to being massive, single programs. One way to segment these systems is to divide them according to which step, or steps of the manufacturing process they address. Typically, these steps include: Product specification; design; planning; production; distribution; field service; and project management.

Of these areas, design, production, and field service, are where most of the expert systems for manufacturing to date have been developed and deployed.

Several of the largest U.S. electronics companies are known to be running multiple expert systems in one or more of these three segments. Among them are AT&T, DEC, Hewlett-Packard Co., Honeywell Bull Inc., Ford Motor Co., General Motors Corp., Hughes Aircraft Co., IBM, NCR Corp., Texas Instruments, Un-

Users favor micros for expert system development and delivery

1987 U.S. manufacturing expert system market



Base = 100 systems included in Cutter survey

Source: Cutter Information Group

Peter Silva/Picture Group

isys Corp., Westinghouse and Xerox Corp. In Japan, Fujitsu Ltd. and Hitachi Ltd. are the manufacturing expert system pioneers.

A whole other set of much smaller companies also are part of the expert system world. These are firms whose entire businesses are geared toward providing expert system software and related consulting/educational services. Most of these companies sell expert system development tools and "shells," or software frameworks upon which customers may build customized expert systems. A handful of these smaller vendors offer completed expert system application packages.

Based on estimated 1987 revenue, D.M. Data says the top five companies in this category are: Intellicorp, Mountain View, Calif.; Teknowledge Inc., Palo Alto, Calif.; Perceptronics Inc., Woodland Hills, Calif.; Carnegie Group Inc., Pittsburgh, Pa.; and Applied Expert Systems Inc., Cambridge, Mass. In several cases, the big-name electronics vendors are the primary investors and/or major customers of these expert system software firms. DEC, TI, and Ford, for example, back Carnegie Group; Ford and Lockheed Corp. are key investors in Inference Corp.; and Control Data Corp. provided initial funding for Software Architecture & Engineering Inc.

COST OF ENTRY

Until fairly recently, expert system technology was prohibitively expensive. Now, with expert system development packages priced from $99 (Paperback Software International's well-received VP Expert), to hundreds of thousands of dollars for the top-of-the-line expert system shells and applications, there truly is something for everyone who wants to experiment with the technology.

In theory, at least, all a customer needs to create an expert system is access to a computer and a copy of a programming language — such as Lisp, Prolog or another AI language; or C, Fortran or any of the other more traditional ones. In practice, however, companies are likely to find that even though their potential payback is great, expert systems for manufacturing are among the most costly expert systems to develop and maintain. Such systems require a lot of customization, such as the development of interfaces between the software and manufacturing equipment. Many times, however, this means calling in an AI consultant.

The cost of hardware used to develop and run expert systems for manufacturing also varies greatly. Machines ranging from $5,000 IBM PC ATs; to $100,000 symbolic processors (also called Lisp machines); to $1 million parallel processors; all can, and have been, used as expert system "development" and "delivery" vehicles. In AI jargon, the hardware on which expert systems are developed is called a development vehicle; the hardware on which the expert system runs is the delivery vehicle.

Most expert system developers today are spending between $1,000 and $5,000 on their expert system development software

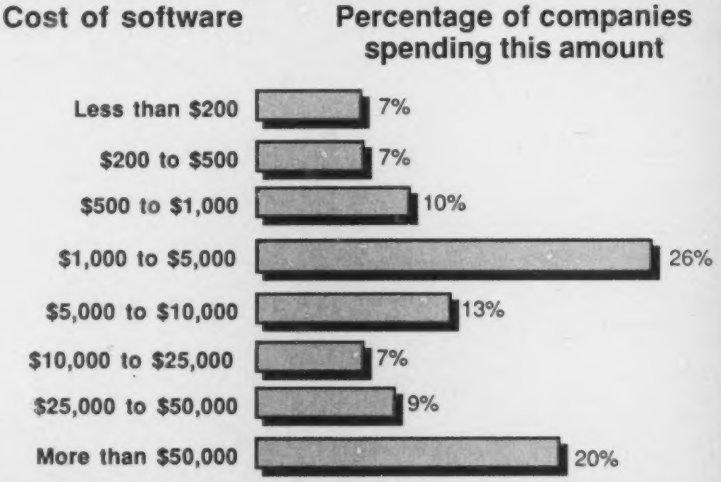
Currently, the most common expert system development and delivery environments are personal computers. These are followed by minicomputers and then workstations — both Lisp-based and others, for instance, those of Apollo Computer Inc. or Sun Microsystems Inc., according to a recent survey by Cutter Information. Additionally, most expert system developers today are spending between $1,000 and $5,000 on their expert system development software. The second most frequent expert system software-expenditure category cited by respondents to Cutter's survey was more than $50,000.

One expense which has not varied the way hardware and software product prices have, is software development costs, measured in terms of programmers' salaries and time. An average estimate of current non-AI software development costs, in man years, according to several software houses, is $120 million per man year.

Programmers skilled in AI development are in high demand and thus command higher-than-average salaries: $30,000 to $60,000 plus, according to AI Consultants in Somerville, N.J. And "knowledge engineers" — individuals responsible for obtaining information from written and human sources and molding it to form a

Software spending is on the rise among companies developing expert systems

1987 software expenditures for expert system projects*



*Expenses counted are software languages, tools, and applications that companies use to create customized manufacturing expert systems. Not included are software packages not used specifically for expert system development, and consulting fees beyond those included in the original software cost.

Base = 100 systems included in Cutter survey

Source: Cutter Information Group

knowledge base — are even more scarce and expensive. TI, Unisys, Teknowledge, and a handful of other companies are attempting to lessen AI programmer shortages by making available written, video and satellite AI courses and seminars. Yet, as the vendors themselves would admit, these educational materials never will take the place of hands-on experience.

D.M. Data estimates that expert system shells and other programming tools can cut expert system development time by as much as 50%. Yet most expert systems can still take many months or years to develop. "Most people say you should start small and always expect the system to require more resources than you originally planned," Cutter's O'Farrell adds.

There are some well-known success stories. Ford's Dearborn, Michigan-based Robotics and Automation Applications Consulting Center, developed a 120-rule system using TI's Personal Consultant in 16 man weeks at a total estimated cost of only $5,000. The system, known as Maintenance Assistant, aids technicians in repairing ASEA robots which are used in applications ranging from welding to assembly, throughout Ford. It has been so successful that Ford has urged other robot makers to embed similar diagnostic expert systems in their products.

Usually, however, the cost of entry runs on the high side. Internally at TI, for instance, nearly every division is working to integrate AI hardware and software into their day-to-day manufacturing processes, says marketing manager Linesch. TI engineers have developed many applications — including fairly complex ones, such as TI's diagnostic system for its epitaxial reactor, a machine responsible for applying thin-film coatings to silicon slides. That system uses TI's Personal Consultant software on TI microcomputers and costs about $10,000. But even fairly small and

An expert system primer

Expert systems are what most people think of when they hear the words "artificial intelligence." The two are not synonymous, however. Expert systems are software programs which enable computers to draw conclusions and "reason," similar to the way people do. Just like natural language, machine vision, and voice recognition systems, expert systems are a subset of AI. Unlike these other segments, expert systems already have been deployed on a wide scale.

Another way to understand expert system technology is to look at it in terms of programming. While standard software programs use step-by-step, predetermined procedures to solve problems, expert systems are created using facts, rules of thumb (heuristics), and other information particular to a certain domain. Rather than crunching numbers, computers which run expert systems process ideas or symbols (hence the term "symbolic processing," which many use when referring to AI). They do this primarily by comparing strings and alpha-numeric characters, and then joining, separating or substituting them.

No matter which industry they come from or where they are used, and regardless of their size or complexity, all expert systems share some basic characteristics. All consist of three primary parts: the knowledge base; the inference engine; and a user interface.

The knowledge base consists of declarative knowledge (information on known, predetermined objects, events and situations) and procedural knowledge (information on possible choices of action). These two types of information may be separate or integrated, depending on the type of knowledge-representation scheme chosen to access the information.

EXPERT SYSTEMS are software programs which enable computers to "reason"

In many cases, it is the inference engine which selects this scheme. The inference engine determines which "rules," or clusters of information, are relevant; accesses these rules; and determines when the appropriate solution to a particular problem has been found. Two terms regularly applied to inference-engine reasoning are forward chaining and backward chaining. The former implies that the system is attempting to reason from facts to a solution; the latter means the system is working from a hypothetical solution to find facts supporting it.

The user interface is probably the least developed part of expert system technology, at least according to the users. Often based on technology from another AI discipline — natural language, which is the capability of systems to comprehend user commands expressed in the user's everyday language rather than structured programming language — the user interface is the layer of software which enables nonprogrammers to interact with an expert system. Ultimately, voice systems, too, could become a part of many expert systems.

Expert system "shells," along with other development tools, can help users write expert systems by giving them a framework upon which to build their knowledge bases. Most shells are either rule-based: following an "if-then" sequence; or frame-based: basing its reasoning on previous examples. To date, the majority of commercially available shells have been fairly generic; that is, they have consisted primarily of skeletal inference engines and user interfaces. Gradually, the top shell vendors are introducing domain-specific shells — some geared toward horizontal applications, such as production planning shells; and others vertically focused, such as financial/banking shells. □

simple expert systems can take six to eight months to develop, resulting in total expenditures of $50,000 or more, Linesch says. Larger expert systems for manufacturing, such as the scheduling system for flexible manufacturing, which is in use at TI's Trinity Mills facility, easily run into many years and "hundreds of thousands of dollars," he admits.

THE OBSTACLES

Theoretically, the steps to building an expert system are fairly straightforward. First, a customer, usually with the help of one or more AI professionals, chooses an application area which the system will address. At this point, the user usually also selects the computer hardware and software which will be used to develop the expert system. One or more "knowledge engineers" then engage in what commonly is called knowledge engineering, or extracting information from various sources (including human "experts") and inputting it into the system.

The inference engine — the software which structures the expert system's knowledge — is then added to this knowledge base, resulting in a prototype expert system. The customer tests the prototype, and makes revisions by adding, changing or deleting information. The system is then retested. Once this process is complete, the system is ready to go.

On paper, of course, all this looks simple. But seldom does expert system development proceed smoothly — especially in the manufacturing segment. Integration of all types of AI technologies into non-AI based environments continues to pose a major hurdle. In a factory, for example, awkward questions arise time and time again. For instance: What type of hardware is best suited to running the system, and is there a Lisp and/or C compiler available for it? Can the expert system handle standard network protocols, such as those which are part of Ethernet; TCP/IP, a defense networking protocol; or Manufacturing Automation Protocol? How can the expert system interface directly with sensors; multiple vendors' design, production, and test equipment; and other software, such as database and MRP systems?

TI's Linesch notes that TI has attempted to stave off some of these difficulties by embedding expert systems into such factory-floor devices as programmable controllers. It also has introduced a C-language version of its PC Plus development package, and is in the process of determining the feasibility of converting knowledge bases into C. And in July, it released Personal Consultant Online, an add-on package which enables users to build expert systems which interact directly with industrial processes by providing multiple interfaces to existing data acquisition and analysis programs.

Another vendor, Gensym Corp., a Cambridge, Mass., start-up which is marketing a real-time expert system development product, has attacked these integration problems by building a system which is specific to the manufacturing environment. Its G2, which was in beta test at four companies as of early September, is a self-contained tool, complete with windowing interfaces, networking, gateways, and simulation capabilities.

In addition to these technical considerations, "people issues," such as building user confidence in the expert system, maintenance and training, are also oftentimes seen as obstacles for expert system vendors and users. Cutter's O'Farrell says some of the most pressing people-related obstacles are:

- Achieving a basic understanding of AI technology. ("Just because you've written things in Fortran doesn't mean you can write an expert system," he says);
- Finding an AI "champion" in your company and then winning support of middle management for your AI project;
- Calculating the potential benefits of your expert system, and proving to management's satisfaction that these benefits will be realized;
- Convincing users (especially non-managers) to use and trust the expert system;
- Having adequate access to the expert or experts from whom you intend to draw the knowledge to create the system; and
- Appreciating fully the effort and time which will be required to develop a truly useful expert system.

AI microprocessors

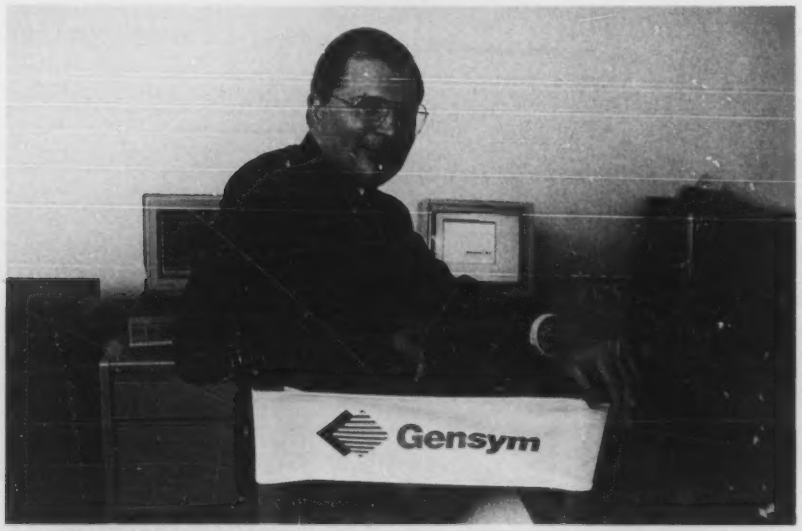
Company	Intel	TI	Symbolics
Part	80386	MegaChip	Ivory
Type	32-bit	32-bit	40-bit
Equivalent transistors	275,000	553,687	400,000
Technology	Double-metal CMOS	Double-metal CMOS	Double-metal CMOS
Resolution	1.5 microns	1.2 microns	1.5 microns*
Die area	152,00 sq. mils	160,000 sq. mils	202,500 sq. mils*
Pins	132	264	144
Package	Ceramic	Ceramic	Plastic
Factory cost (estimated)	$55	$110	$60

Currently, all types of microcomputers, minicomputers, mainframes and symbolic processors are used as both development and delivery vehicles for expert systems. But the new generation of microprocessors, listed above, promise to narrow the development-delivery gap as well as the AI-DP gap. Comments D.M. Data Inc.: "It will be interesting to note how each of these chips fare; not only as the basis for particular machine architectures, but most especially as coprocessors and components for add-on boards. Since there is already talk of an Intel AI-based 80486 processor, and RISC chips are showing up in engineering workstations, each of these chips will have to prove their worth within a two-year timeframe."

*After die shrink. Source: D.M. Data Inc.

THE COMPETITION

Only a handful of electronics companies have attempted to go commercial with their expert system technology. And those which have, seem to be consciously limiting their participation. For example, NCR recently completed the first expert system based on the Proteus expert system shell designed by the participants involved in the Advanced Computer Architecture Program at the Austin, Texas-based research consortium, the Microelectronics & Computer Technology Corp., otherwise known as MCC. The system, Design Advisor, will aid NCR engineers in designing semiconductors. NCR says it also will offer the product to its customers. It will be priced somewhere between



GENSYM's LOWELL HAWKINSON: "The major issue [in manufacturing] is handling things in real time"

Ted Fitzgerald

$4,000 and $8,000 and will run on Symbolics Inc. and Apollo hardware only.

"Most manufacturers are still in the learning and prototype stages," agrees Peter Pennisi, director of knowledge systems marketing for Unisys.

Even though the Detroit-based Unisys has developed a printed circuit board fault-diagnostic expert system and a just-in-time mainframe manufacturing one, it intends to keep both systems proprietary, Pennisi says. Instead, like DEC, TI, Xerox, and others, it is concentrating its commercialization efforts on expert system development tools, educational materials, and, in Unisys' case, hardware (in the form of Explorer Lisp machines which it purchases on an OEM basis from TI). For the long run, Pennisi says, "we're working on adding and embedding intelligence into software we already have, especially the manufacturing software we sell into vertical markets." Unisys also is continuing to evaluate the possibility of selling expert system shells (called Power Packs by the former Sperry Corp.) for specific vertical markets.

Some market watchers consider Operations Advisor from Palladian Software Inc. to be the first complete manufacturing expert system application package. But the hottest competition in expert systems for manufacturing is occuring these days in the expert system shell arena. Very few manufacturing-specific shells exist; in fact, some industry watchers say that Picon, a real-time product developed by Lisp Machines Inc. (now part of Gigamos Holdings of Montreal, Canada), and the recently introduced G2 from Gensym, are the only ones on the market. Gigamos and Gensym currently are involved in litigation regarding the rights to the Picon technology.

"The major issue [in manufacturing] is handling things in real time," [illegible] out Lowell Hawkinson, chair[illegible]and chief executive of Gensym. "Ye[illegible]lmost all of the existing expert syst[illegible]m tools and shells are more suited to more static kinds of problems. They almost never have significant development of time-based reasoning."

Despite these deficiencies, the more generic expert [illegible]stem shells — from vendors such as the Carnegie Group, Inference Corp., Intellicorp, Software Architecture & Engineering and Teknowledge Inc. — are finding their way into manufacturing expert system development at many electronics companies. The demand for these products should increase even further, since within the past two years, vendors have made them available in C and/or Lisp, rather than Lisp only. (Intellicorp is the sole major vendor which sells only Lisp versions of its products. Teknowledge, on the other hand, sells C-based software only.) The migration toward C was spurred by customers' needs to integrate their AI applications with non-AI ones.

This kind of integration is not easy, however, as has been proven by past experience at Los Angeles-headquartered Inference. Inference attempted to recompile in C a symbolic processor-based Lisp version of its ART software product for the DEC VAX. It released the resulting product in April and promptly sold 60 copies. But there were so many bugs in it, the company concedes, that Inference was forced to pull it from the market. It is now reimplementing Lisp versions of ART for the VAX using commercially available VAX Lisp compilers — packages which were not available when the company made its initial decision to go with C.

Despite all the trouble, the move toward VAX and C has been worth it for Inference, according to Abraham Gutman, assistant to the president. Between 25% and 40% of the 600 copies of ART installed worldwide are being used to develop expert systems for manufacturing, he says.

Until the past year or so, "there was a tendency among industrial engineers to see AI as too difficult. As a result, AI was introduced slowly in areas like monitoring, rapid diagnosis, and process planning," Gutman explains. Now, however, companies are "moving away from academic diagnosis, maintenance, and configuration [concerns]." The new question which companies are trying to solve via expert systems for manufacturing, Gutman claims, is: "How is it we can improve the planning process?"

Another tack a number of the expert system shell vendors are taking to make their products easier to integrate into real-world applications is the introduction of domain-specific shells. The Carnegie Group, for one, will introduce two "class-specific" development shells within the upcoming few months, according to manager of sales, Jay Leasher.

By the end of 1987, Carnegie also plans to make available a tool which will enable customers to develop diagnostic-type expert systems more rapidly. The tool will be available in two versions: one for development, initially for TI Explorers; and one for delivery, for IBM PC AT and DEC MicroVAX systems. The other shell, which Carnegie Group expects to begin shipping in the second quarter of 1988, will aid customers in building discrete-event modeling and simulation expert systems. It most likely will be available for the MicroVAX and possibly some other workstations, Leasher says.

Foley is a Washington, D.C.-based business and technical writer.

IBM had its electronics *glasnost*. Is it Japan's turn now?

To remain competitive, Japanese companies should become less vertically integrated. An opportunity for the U.S.?

By Alberto Socolovsky

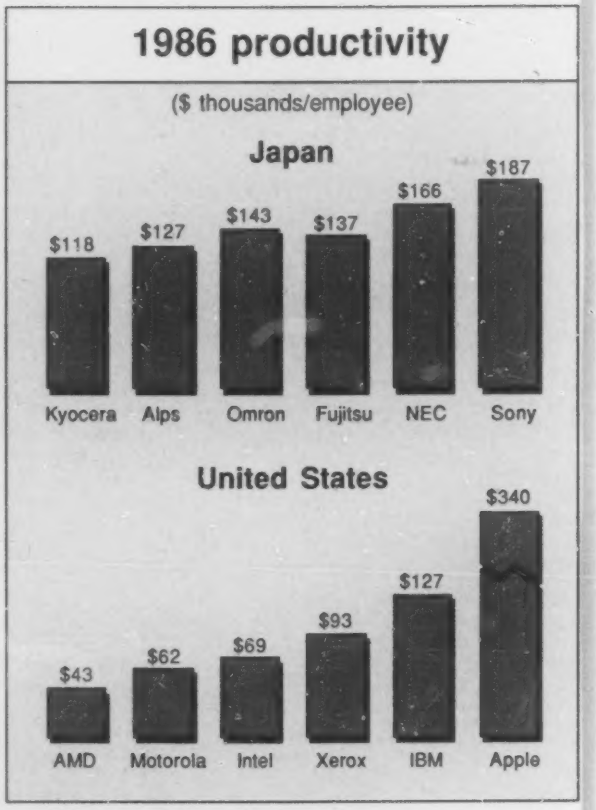
There was a time when IBM looked like Fujitsu looks today. Two decades ago, IBM made a lot of its own components and subsystems, as do Fujitsu and many other systems manufacturers from Japan. These Japanese companies go a step further by selling them too.

The model — vertical integration to increase value added within the company or to enhance proprietary technology — worked for IBM, but not for dozens of U.S. electronics companies which tried to copy it on the assumption that what was good for IBM was also good for the rest of the electronics industry. The model did work for the Japanese electronics industry, which was under different financial constraints than its U.S. counterpart.

Today, however, IBM looks more like its smaller competitors: less vertically integrated, more dependent on the rest of the industry. The world's No. 1 computer manufacturer is undergoing an electronics *glasnost*, openness toward companies it would have considered competitors only 10 years ago, and openness toward components suppliers which at one time used to worry about disclosing their technology lest it wind up in Big Blue's internal production.

The difference between vertically integrated Japanese companies and the increasingly concentrated American ones is best evidenced by comparing the ratio in revenue per employee for both countries. There is hardly a difference in Japan among components and systems manufacturers, whereas in the United States, the productivity of a profitable computer manufacturer such as Apple Computer Inc. is more than five times larger than its microprocessor supplier, Motorola Inc. The reason is that Apple couldn't possibly make microprocessors profitably, while Motorola can make them and be profitable at a much lower level of revenue per employee.

Now that Japan's financial structure is changing as the yen finds its rightful value among the world's merchant currencies, Japanese companies may find that *glasnost* is not just for IBM. And, when they look for suppliers that can be both profitable and help them make a profit, they should look first in the United States.



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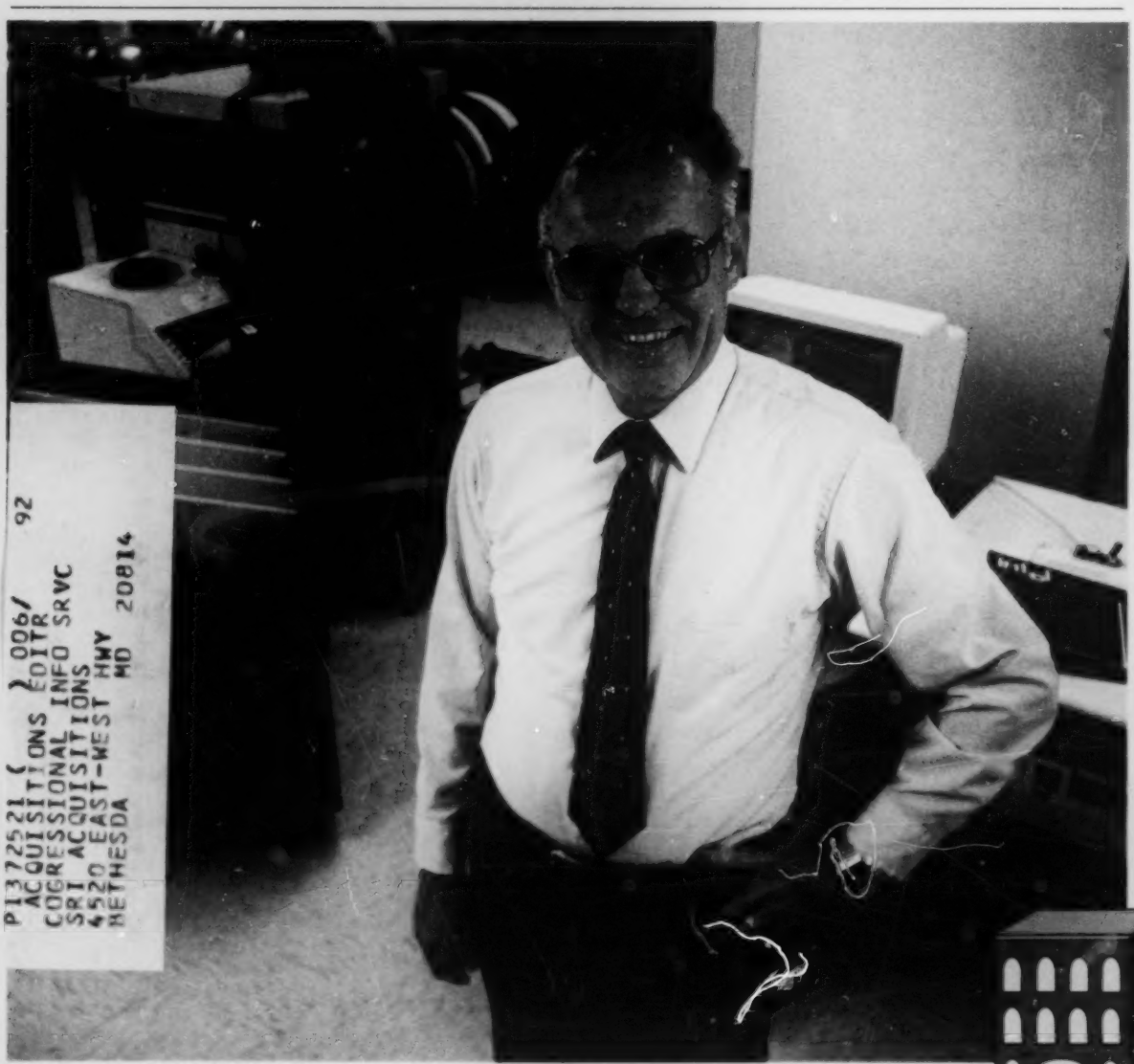

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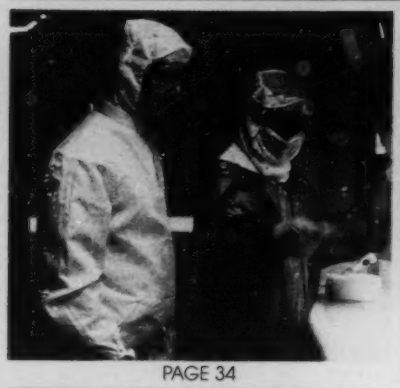

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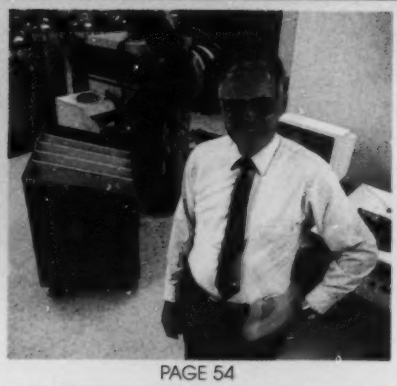

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Computer production expected to accelerate in the new year

Evidence is accumulating that computers are now a cyclical industry, just like other capital goods

Since turning up in the last quarter of 1986, industrial production of computers and office equipment has advanced steadily through the first three quarters of 1987. Production is expected to accelerate through 1988, according to Cahners Economics. Such momentum will be welcome news for the second-tier players who've continued to struggle even as the likes of Compaq Computer Corp., Digital Equipment Corp. and NCR Corp. have shown exceptional revenue and earnings growth in recent quarters.

According to Marc Shulman, Salomon Brothers Inc. analyst, computer manufacturers and their electronic component suppliers could enjoy a boom market in 1988. Shulman bases his enthusiasm on the convergence of three macroeconomic indicators. For the first time since early 1984, all three — corporate profits, industrial production and capital goods orders — are rising. Pretax corporate profits rose by 19% in the second quarter. And between May and July, industrial production rose at an annualized rate of 7.5%. Orders for non-defense capital goods surged by 32.1% during the same period. Shulman foresees an explosion in equipment sales that will extend the 1987 recovery for their component suppliers as well.

If the boom materializes, it may simply be further confirmation that computers have become more of a traditional cyclical capital goods industry. In contrast with pure growth industries that defy broader economic cycles, capital goods industries typically prosper during the latter stages of business recoveries. During this period, companies begin to strain existing capacity and have sufficient cash to invest in new plant and equipment.

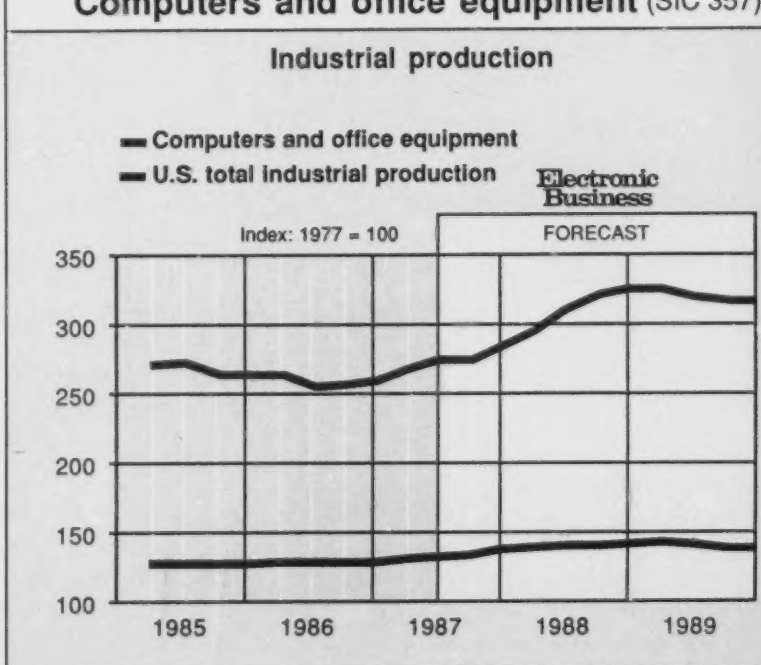
Companies such as Data General Corp. and Control Data Corp. would certainly welcome a cyclical upturn. IBM, which saw little revenue growth in the first six months of this year (versus the same period in 1986), could be the chief beneficiary of a capital spending boom, especially if mainframes return to customer shopping lists. But for some market leaders, a revival in capital spending would represent the extension — not the inception — of very good times.

Apple Computer Inc., for example, has been enjoying quarterly revenue gains of 30% or more over the past year. NCR has forecast record revenue and earnings for all of 1987. Earnings of Amdahl Corp. in fiscal 1987 are nearly triple those of 1986. DEC just keeps rumbling along, closing in on the $10 billion revenue checkpoint in its fiscal year ended June 30. Compaq, Tandem Computers Inc. and Sun Microsystems Inc. are all likely to grow in excess of 25% on their way to record revenue and earnings performances. But others — for example, Data General, Control Data and Wang Laboratories Inc. — will need a macroeconomic boost to recover dissipated momentum.

Data from Cahners Economics offers these firms some encouragement. Bookings of new business for the first seven months of 1987 are running almost 6% ahead of the same period last year. Backlogs, at a seasonally adjusted $19.2 billion, were at their highest level since the end of 1985. Except for such overly-contested market sectors as engineering workstations and minisupercomputers, prices have been fairly firm, according to industry analysts. With export business still strong in Europe and signs of new life in the Far East, the expected rise in U.S. capital spending could provide the rising tide to lift all ships.

NORM ALSTER

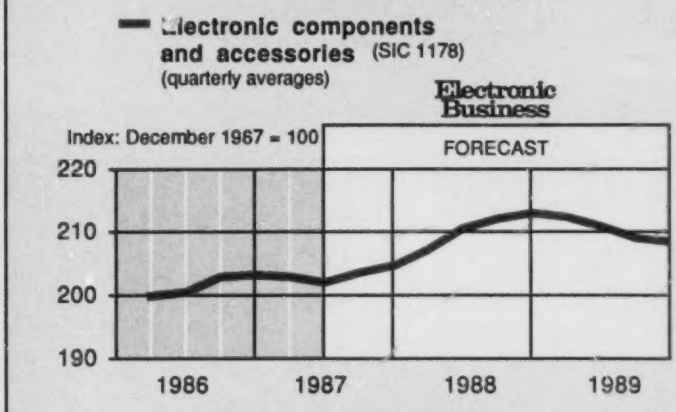
Computers and office equipment (SIC 357)



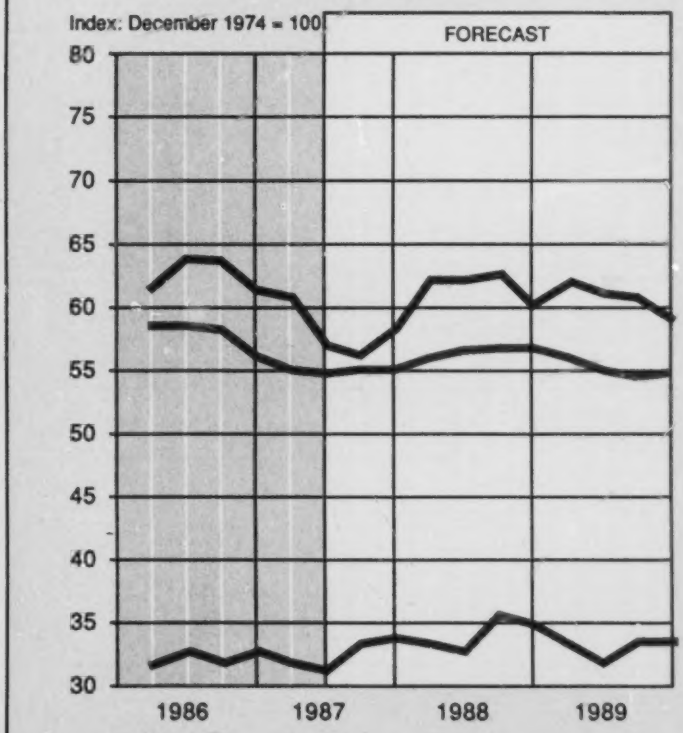
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Producer price indexes

Electronic components



Passive components



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic components & accessories
Producer prices for electronic components and accessories fell 0.4% in the second quarter of 1987 but appear to have bounced back 1% in the third quarter. Higher prices are coming from capacitors, resistors, semiconductors and especially connectors. Integrated circuits manufacturers, on the other hand, have been hard pressed to impose price increases. As the three examples below dramatize, most IC prices are much weaker today than a year ago. The next 12 months will see a change in these circumstances as higher demand forces all component prices up.

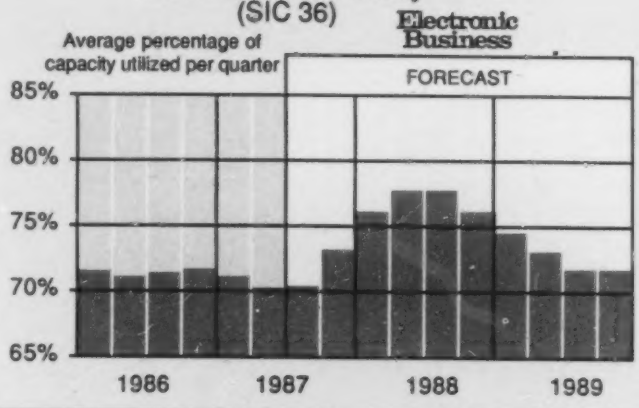
Digital bipolar ICs
According to the U.S. Bureau of Labor Statistics, prices of digital bipolar ICs fell 5.4% in the second quarter and appeared headed for another 1.9% decline in the third quarter. These prices are 10% and 11% below the year-ago levels. Prices are expected to fall 7.2% by year-end, and then rebound 6.2% next year. Leadtime information gathered by *Electronics Purchasing*, ELECTRONIC BUSINESS' sister publication, shows the supply of digital ICs is already tightening. Rising leadtimes, which indicate buyers are waiting longer to receive their orders, put upward pressure on prices.

Digital MOS ICs
Producer prices of digital MOS ICs also fell in the second quarter by 2.5%, leaving prices 5.5% below their year-ago level. But the turnaround in these product prices has already begun. Early evidence for the third quarter indicates prices jumped 7.7%, so by the end of 1987 prices will have actually risen 0.7% above 1986 prices. In 1988, prices are expected to surge 4.5%, then drop 3.1% in 1989. Growing demand for logic prices is leading to tighter supply conditions and firming prices. These Labor Department statistics are a useful indicator of product price trends as long as list prices are an accurate indication of the actual transaction price.

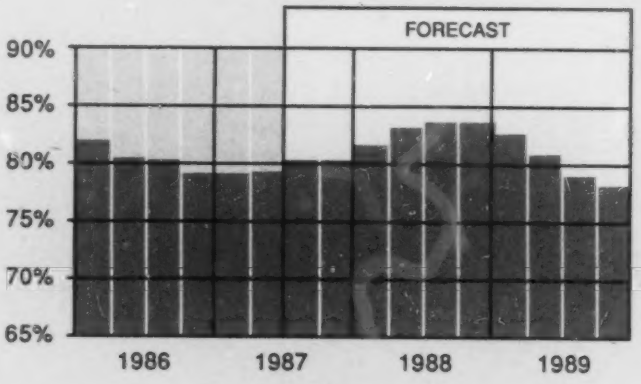
Linear ICs
After falling 1% in the second quarter, prices of linear ICs rose an estimated 1% in the third quarter. By the end of this year, prices will still be 5.4% below 1986. Demand for linear ICs is not expected to be as strong as for other devices over the next year, keeping 1988 price increases below the 3% threshold. Leadtimes for linear ICs ratcheted upward from a low of five weeks in October 1986 to nearly eight and one-half weeks last summer. But leadtimes will not rise much above 12 weeks next year, which is another indication of only modest price rises to come.

Plant utilization

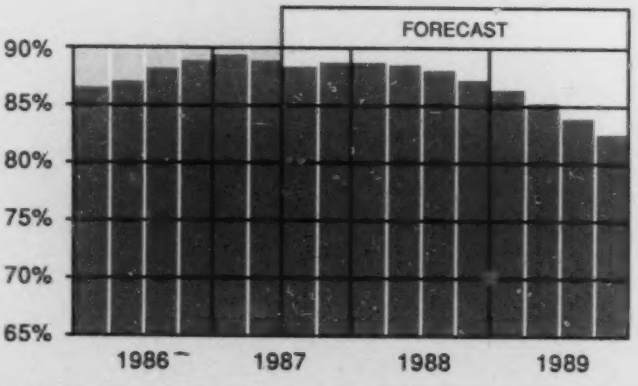
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical and electronic machinery operated at an average 70.3% of capacity during the April through June period, marking the second straight quarter of decline in utilization. Early reports for the third quarter show capacity utilization sticking at about that rate, the lowest level since the first quarter of 1983. However, the major segments within electrical machinery, most notably electronic components and communication equipment, recently have enjoyed healthy increases in new orders, and backlogs are on a slow rise. Operating rates should reverse their downward trend shortly and move up into the 73% to 78% range in 1988, but drop 3% to 6% in 1989.

Instruments

The factory operating rate of the instruments industry advanced slightly in the second quarter to 79.4% from the first quarter's 79.2% level. Estimates for the third quarter indicate rates are edging above the 80% mark. This upward swing is expected to continue. Orders and shipments for this industry are up from their year-ago levels and growth is expected to be strong for 1988. Anticipated increases in business investment, particularly equipment spending, will be a positive influence on production in this industry. Operating rates are expected to increase another 3% to 4% for next year, reaching their highest levels since the end of 1984. Utilization will fall off again about 5% in 1989.

Aerospace

Capacity utilization for aerospace manufacturers averaged close to 89% for the second quarter of 1987, about the same level as the prior two quarterly periods. Production in this industry shows continuing signs of softening due to the slowdown of defense spending. Although order backlogs are at high levels, new orders are not growing as quickly as in the past. This will exert downward pressure on the historically high operating rates the industry was experiencing in late 1986 and early 1987. Capacity utilization will decline over the next two years to the lowest levels since the beginning of 1985.

MATERIALS

Chip makers' choice: Clean up now or pay later

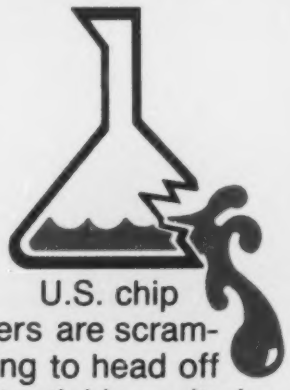
Health and safety issues may soon be a top priority in the U.S. semiconductor industry

The cost of doing business in the semiconductor industry may be going up again, but not because of Japanese competition or the falling dollar. Instead, health and safety issues in the manufacturing areas are coming to the forefront now, as watchdog groups and opponents of toxic chemicals band together to challenge the industry's "clean" status.

Once thought of as a very clean and injury-free industry, the semiconductor realm has come under attack in recent years, first from environmental groups alerting the public to the dangers of toxic chemicals polluting groundwater, and most recently from industry employees themselves, who are fearful of the chemicals they are exposed to in the workplace.

As a result, U.S. semiconductor companies are scrambling to head off potential lawsuits and workman's compensation actions by employees who claim that their health has been impaired on the job. How much are semiconductor manufacturers spending on internal safety programs? Based on interviews with more than a half dozen manufacturers, ELECTRONIC BUSINESS estimates that semiconductor companies spent roughly 1% to 2% of total revenue on in-house educational programs, safety engineers' salaries and other non-capital-equipment costs related to employee health and safety. If the total production of semiconductors in North America for both merchant and captive operations was $16.8 billion this year, as Integrated Circuit Engineering Corp. suggests, then the industry spent between $168 million and $336 million on health and safety this year.

Some industry officials suggest that this may be more than enough money to cover the cost of current health concerns. The Semiconductor Industry Association (SIA), for example, points out that the rate of illness and injury in the semiconductor industry is less than half that of other manufacturing sectors — 4.1 cases of illness and injury per 100 employees in 1984, compared with a 10.6 per 100 rate for manufacturing overall. And Richard Bolman, health, risk and safety manager for semiconductor manufacturer Siliconix Inc. says, unequivocally, that "the fab is *not* a dangerous place to work. There is just as much exposure, or more, to chemicals in your home than in the fab."



U.S. chip makers are scrambling to head off potential lawsuits by employees claiming that their health has been impaired on the job

But everyone agrees that worker safety should be a top corporate concern at every U.S. semiconductor company.

The DEC study

Safety, of course, is not a new issue in the industry. Five years ago, the National Institute of Occupational Safety and Health acknowledged in a report the link between glycol ethers, which are widely used as solvents throughout the industry, and reproductive damage in male and female test animals. As a result, the Environmental Protection Agency promptly requested that the Occupational Health and Safety Administration (OSHA) more strictly regulate worker exposure to these chemicals.

Concern was heightened, however, after widespread news reports of a study last year of the Digital Equipment Corp.'s LSI semiconductor facility in Hudson, Mass., by researchers at the University of Massachusetts School of Public Health. The final version of the controversial UMass report has not yet been published, but researchers said that preliminary findings indicate that women workers at the plant, which builds custom chips for DEC's MicroVAX computer series, have experienced double the average number of miscarriages of women nationally.

The report's impact on the semiconductor industry, which employs 75,000 production workers in the United States alone, has been far-reaching and profound. In the wake of the report, AT&T reportedly barred all women of childbearing years from working on its fab lines; other firms too, such as Fairchild Semiconductor Corp., have excluded pregnant women from at least one site. And most companies now offer women the option of transferring out of fab facilities and into other areas of the company, if they so desire.

Trade groups in the industry are also attacking the problem. The SIA in Cupertino, Calif., claims it has established the only industry-sponsored occupational injury and illness surveillance system in operation in the United States. And Sematech, a government-sponsored consortium investigating new technologies in semiconductor production equipment, reports it has been holding a series of closed-door meetings on health and safety issues in the industry. Likewise, the packaging group at the Austin, Texas-based Microelectronics

Computer and Technology Corp. is also doing research the subject.

Not to be outdone, the federal government has also gotten into the act. Former U.S. Labor Secretary William Brock, prior to the announcement of his resignation from that post in mid-October, asked OSHA to look into possible hazards for workers involved in chip making. And there is now health and safety legislation pending in the U.S. House of Representatives that could also affect the situation.

While some industry officials warn that watchdog groups are making a mountain out of a molehill, there is at least one significant example of employees who believe that they have been injured by exposure to chemicals used to manufacture printed circuit boards. That industry uses many of the same chemicals as the semiconductor industry, experts say. One hundred fifteen workers of the former GTE Communications Systems Co.'s printed circuit board plant in Albuquerque, N.M., sued GTE: the case was settled out of court earlier this year. Sources estimate the total settlement was in excess of $3 million. These same 115 people, along with 85 other fab workers, also have filed product liability suits against more than a half dozen chemical companies.

Ticking away in the background, industry officials realize, is a potential timebomb in legal proceedings, if women workers or future generations of children claim, either rightly or wrongly, that birth defects were caused by corporate negligence in the semiconductor industry. Notes Meta Mendel-Reyes, director of the Santa Clara Center for Occupational Safety and Health, a watchdog group, problems with toxic chemicals could prove to be extremely costly to employers "if deformed children start suing."

But those are only the long-term problems. In the short term, chip makers also face possible litigation stemming from what has become widely known in the industry as "exclusionary" policies. Some women workers, for example, claim that manadatory, or even voluntary, exclusion from semiconductor production lines is discriminatory because fab work is often one of the higher paid blue-collar jobs in the company.

Jeanne Patterson, a former senior operator at Siliconix, for example, was denied disability insurance after her doctor advised her not to return to her job when she became pregnant with her second child. She claims that exclusionary policies at her company and potential hazards in semiconductor manufacturing, "make me choose between having a family and having a job." Although Siliconix claims that its policy is to offer a transfer to women who don't want to work around chemicals to other jobs at equivalent pay outside the fab, Patterson took her disability case to the California Supreme Court, and won. She says she is currently planning to sue Siliconix for back wages as well.

RICHARD BOLMAN, Siliconix's health and safety manager is unequivocal: "The fab is *not* a dangerous place to work"

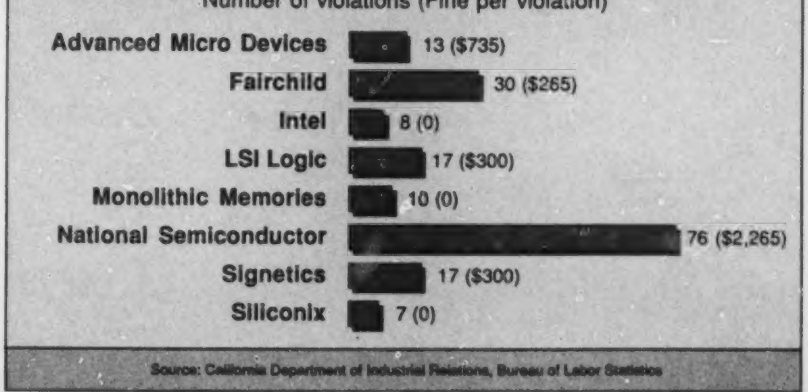
Unfortunately for the industry, Patterson's may not be an isolated case. ELECTRONIC BUSINESS has learned, for example, that the American Civil Liberties Union (ACLU) is considering suing a variety of organizations over the issue of exclusionary policies, including AT&T, DEC and the SIA.

"The [semiconductor] companies are being very close-mouthed on particular personnel policies," says Joan Bertin, associate director of the ACLU Foundation's Women's Rights Project, one of the 40 consumer, women's rights and health groups which have formed a coalition to pressure the semiconductor industry to protect workers' rights. "But if things don't proceed well, we'll have to think about litigation."

Not surprisingly, many chip makers are now taking steps to make their fab areas safer. At Signetics Corp., for example, the company allocates about 1.5% to 2% of annual sales for safety programs, and that does not include capital expenditures. And despite competitive pressures, Signetics claims its policy is to put safety measures above everything else, according to health and safety director Lou Yakubek. By the same token, Siliconix says it spent about $1.5 million last year on health and safety. And, although Intel Corp. declines to give a total figure for expenditures last year, safety manager Craig Modahl says that his company probably spent $1 million alone on rubber gloves.

DEC, too, claims it maintains

Occupational safety violations by semiconductor manufacturers in Alameda and Santa Clara County, Calif. — January 1979 - June 1987



Source: California Department of Industrial Relations, Bureau of Labor Statistics

MIKE VAUDEREIL, National Semi's safety man, says National is planning a switch to less toxic photoresist chemicals

some of the most stringent cleanroom standards in the industry. The Maynard, Mass., minicomputer company employs what could be the largest dedicated safety force in the semiconductor industry — 16 safety engineers and technicians out of a total semiconductor production workforce of 500. In addition, despite the complaints in the UMass study about alleged health hazards at the firm, DEC employs continuous gas and chemical monitoring systems, and maintains its own computer-based worker-exposure tracking system.

IBM, which operates the largest captive semiconductor business in the country, also operates state-of-the-art monitoring and control systems in its fab areas. Like DEC, IBM has set acceptable worker exposure standards above those required by the OSHA.

Additionally, as a result of the UMass study findings, IBM advised employees in May that it would conduct its own worker-safety study under Dr. Morton Corn of Johns Hopkins University. Actual data collection is expected to begin sometime during the first quarter of 1988, but the corporation has already notified production workers that it sees no reasons for concern. Since its inital announcement in May, a handful of IBM workers requested and received temporary transfers from the fab lines.

Meanwhile, other companies are substituting less toxic chemicals for toxic chemicals, lessening the concentration of the chemicals used, or substituting liquids or solids for toxic gases such as phosphine or arsine.

However, all of these changes cost money. "Don't let the chemical companies fool you," Intel Corp. health and safety manager Craig Modahl says. "It takes a lot of effort and time to switch chemicals."

Intel, which is currently switching from arsine to arsenic, also may switch from hydrotetrachlorine (used in metal etching) to chlorine, Modahl says. "That was done just from a safety standpoint. Hydrotetrachlorine is not a chemical you want to be using."

INTEL HEALTH and safety chief Craig Modahl: "It takes a lot of effort and time to switch chemicals"

Another area of concern is solvents such as glycol ethers, the key ingredient in the photoresist process, which is itself a vital part of process manufacturing. Any chemical change in this area would likely also require a process change, according to Gary Amstutz, technology director for KTI Chemicals, a subsidiary of Union Carbide Corp. And process changes are often very expensive. "There is no direct replacement [of one chemical for another]," Amstutz says, "because with different chemicals, there are performance changes, and that is very important because of the end-

Washington watch: S. 79; H.R. 162

This fall, the full Senate and House are expected to take up the High Risk Occupational Disease Notification and Prevention Act of 1987, or Senate bill 79; House of Representatives bill 162.

The bills advocate the establishment of a national panel of health experts to determine which chemicals are hazardous substances; and then to alert workers to the dangers of exposure. The bills significantly extend rights to workers beyond those accorded them by the Federal Health Hazard Communication Standard — the national "right to know" initiative, which requires employers to tell employees about potentially toxic substances and possible consequences of working with them.

The High Risk Notification bills are opposed by the National Association of Manufacturers and various associations representing small businesses. They claim the bills could result in extensive litigation and force them out of business.

But many big companies, including AT&T, Digital Equipment Corp. and IBM, are behind the legislation, and the word coming from many Washington insiders is that passage of the bills is virtually assured.

Some watchdog groups, however, claim that the current compromise versions of the bills are much weaker than when they were first introduced. Initially, the legislation would have allowed the results of studies performed on animals to be used as proof of possible toxicity of various chemicals. Now, human studies only are admissible as evidence. The bills also make no mention of exclusionary employment policies. □

Tim Davis

use application."

In addition, it sometimes takes a long time to incorporate changes into the production process. Some experts say a change in chemicals can cost a chip maker as much as four to six weeks in production. Notes Mike Vaudereil, safety manager at National Semiconductor Corp., National is now planning to switch to less toxic photoresist chemicals, but the evaluation process alone could take from six months to a year. Restructuring production lines is also a very labor-intensive operation, he says, and can only occur at National in one fab area at this time.

In fact, according to AZ Photoresist Products, a subsidiary of Hoechst AG, not very many semiconductor companies have switched over to less-toxic chemicals, despite some important technological advances in the field. Although several semiconductor companies are currently evaluating safer products, most customers are also concerned with higher performance, according to Richard Timmins, director of the chemical supplier. Safety is usually only one of several considerations.

Intel, for example, has not yet switched from glycol ethers, although the company is currently evaluating the switch. According to safety manager Modahl, it's important to make sure that a switch is a good substitute, not just an expedient one. Intially at least, some of the substitute glycol ethers produced by chemical companies were really no safer than the products they were intended to replace, Modahl claims.

> The impact of the UMass report on the semiconductor industry has been far-reaching and profound

Nevertheless, the industry appears to be serious about evaluating safer chemicals. Virtually all of the companies in the industry have someone in the firm looking at substitute materials. And Texas Instruments Inc. has even set up a separate group to study the long-term implications of a chemical switch.

Most semiconductor companies, however, do appear to be spending money on improving worker safety through education. And most firms routinely offer workshops, workbooks and video tapes on health and safety issues. Everyone at TI, including non-fab workers, goes through a basic training program in chemicals. In addition, fab workers receive specific training in their area of expertise.

Because a large percentage of fab line employees are typically workers whose first language is not English, training programs must frequently be tailored to meet their needs. Often, companies try to accommodate non-English speakers with increased use of graphics and pictures in their workbooks. Some companies, like National, have even experimented with conducting training programs in several languages.

Concerns linger

But some watchdog groups claim that the industry is dragging its feet. Leonard Siegel of the Pacific Studies Center in Mountain View, Calif., claims that the industry should be spending more money on research. "The cost of not doing it [making fabs safer] is potentially enormous," Siegel says. "Look just at what companies in this Valley paid to clean up toxic spills — $100 million."

"Health and safety issues in the

In search of the perfect study

One of the biggest problems in coping with health and safety issues in the semiconductor industry is the lack of hard evidence linking chemical exposure to specific health problems.

There are several reasons for this. First the industry is relatively young, and many chemicals have not been on the market long enough to support studies on their long-term effects. Second, there have been very few studies done in the industry, and none widespread enough to draw any significant conclusions. Third, different chemicals have different responses. Possible cancer-causing chemicals, for example, could conceivably cause cancer after just one exposure; other chemicals have a threshold over which they do damage.

The Digital Equipment Corp. study is a case in point. According to a number of doctors and industrial hygienists, sample size of the study is too small to be considered statistically valid — or more important, perhaps to show a link between miscarriages and chemical handling. On the other hand, proponents of the study say that glycol ethers, which were singled out by researchers at University of Massachusetts School of Public Health, have been cited by OSHA as early as 1984 for posing possible hazards to the reproductive system.

Either way, the UMass report suggests that more studies must be done. Concern over the issue has prompted the Santa Clara County Board of Supervisors to draft a resolution calling for the SIA, along with its members, to conduct an independent study of this issue in order to obtain valid results.

In December 1986, the SIA took the initial steps toward doing just that. Its Occupational Health Committee established a special task force (called the "Digital Task Force") to review the DEC study and present the SIA board with its findings. The task force, in its March report, found "significant deficiencies" in the DEC study. It also advocated that individual SIA dmembers undertake studies on their own. IBM and Texas Instruments Inc., among others, are known to be doing this.

The SIA also formed a special "Director-level Task Force on Worker Health" to work with SIA members that are interested in conducting a joint health study. In July, the SIA named a panel of five independent researchers charged with creating a protocol and developing a request for proposals for such a study.

If all goes as planned, the SIA study could begin as early as the first quarter of 1988. □

fabs are still a troublesome problem," adds Dr. Joseph R. LaDou says, a physician at the Peninsula Industrial Medical Clinic in San Jose. Worker's compensation data from the state of California still shows a disturbing incidence of systemic (chemical) poisonings in the semiconductor industry, he says — with an occupational illness rate of 36.5%, compared with 21.5% for all industries and 31.6% for other types of electronics manufacturing.

Moreover, the higher miscarriage rate cited in the DEC study is only one possible effect of chemicals used in semiconductor manufacturing. The study also showed that both men and women experienced a higher incidence of sore throats, dizziness, nausea and bad headaches while working in the fab.

Consequently, removing pregnant women from the fabs is not, in itself, an adequate solution. According to toxicologist Dr. Selina Bendix, president of Bendix Environmental Research, a consulting firm in San Francisco, what is unsafe for pregnant women most likely is unsafe for men. "What frustrates me the most," she says, "is that people don't realize that men's reproductive systems are often even more sensitive than women's, so moving women out of the fab is the wrong decision. What about the men? It has to be made safer for everyone."

> Ticking away is a potential timebomb in legal proceedings, if researchers are able to establish a positive link between chemical exposure and birth defects

Bendix also points out that damage from chemicals is often incurred in the first four to six weeks of pregnancy, before the women even know they are pregnant. Among men who have been exposed to glycol ethers, lowered sperm count and other testicular problems have been cited by some researchers. That has led some health experts to predict that fetuses can be damaged by just the male partner's exposure to chemicals.

VALERIE RICE and MARY JO FOLEY

COMPUTER-INTEGRATED MANUFACTURING

As DEC's manufacturing customers go, so goes DEC

From computer vendor to systems integrator: DEC is changing its approach to the factory floor

In the realm of computer-integrated manufacturing — where islands of automation are being tied together via networks and computers — manufacturers are in search of vendors that can provide the most far-reaching solutions to their complex problems.

One vendor anxious to meet all of its customers' demands is Digital Equipment Corp. This $8.4 billion Maynard, Massachusetts-based corporation already holds the largest market share in computers and peripherals used in CIM applications. In 1986, DEC held a 35% share of the $5.9 billion domestic market, according to research firm International Data Corp. (IDC), of Framingham, Mass. IBM came in second with 29.6% and Hewlett-Packard Co. was No. 3 with 9.1%.

But the race for the greatest installed base of hardware is giving way to a new contest. Now, the equipment giants — DEC, HP and IBM included — are vying to become masters of systems integration. DEC's ultimate ambition in the CIM marketplace is to provide systems integration for an entire corporation, says Donald Bell-Irving, marketing group manager of the Industrial Automation Systems group at DEC's Westborough, Mass., facility. Although such far-reaching solutions might sound a bit lofty, major U.S. manufacturers are considering just that.

Take the case of CIM user Motorola Inc. There, the key emphasis is, "aiming towards the computer integrated enterprise. Not just in the manufacturing area, but the entire enterprise," says Donald Walker, vice president and director of semiconductor automation at Motorola's Phoenix, Ariz., headquarters. But to get there, Walker says, the company had to start at the bottom, first finetuning each process and item of equipment before getting ready to begin integration.

Today, this $5.8 billion semiconductor giant has an advanced factory "prototype," which encompasses a fully automated, start-to-finish semiconductor assembly line. This Chandler, Ariz., pilot factory is used to demonstrate concepts in integrated manufacturing. Although Motorola could have completed this project in-house, Walker estimates it would have taken an estimated five years to do so. Instead, the company contracted with an outside consultant that had experience in computer integration projects and had hardware and software ready to go.

> DEC's networking capability is its "ace in the hole"
>
> Andrew Chatha of ARC

Vendor bias

Whether or not Motorola would consider turning to a DEC or IBM to provide such services is now moot. Walker has indicated that much of what was done in Chandler will be duplicated in Motorola factories worldwide, but will be done mostly in-house using application software contractors when necessary. Walker noted that he has "no bias for or against DEC or any other major computer vendor," regarding the use of their services as systems integrators. However, he voices possible concerns regarding vendor equipment bias and lack of flexibility. Motorola, in fact, insisted that its contractor change from the computer it was offering to a DEC system. In such situations, he adds, "a computer manufacturer wouldn't be able to do that. They'd be less flexible."

Whether or not this issue will present problems for DEC remains to be seen. DEC's Bell-Irving points out that his company is interested in business only where DEC systems can

play an important role. "You're probably not going to find us being successful competing against IBM," he says. "To integrate where products are all IBM doesn't make sense for us." Rather, he adds, DEC wants to leverage the expertise it has with its own computing systems and networks. But Bell-Irving also cautions against taking the simplistic view that the company's thrust in CIM is primarily to sell hardware. The No. 1 reason for offering computer systems integration, he says, is because "customers are asking for total solutions, and we view it as our role to provide products and services."

In order to do just that, DEC has been forced to do some rethinking, as well as reworking some old habits. "In the past, we relied very heavily on original equipment manufacturers to provide and sell solutions. We sold only the hardware," Bell-Irving notes. "Today, we are actively developing solutions with applications partners so that we can sell real business solutions. We are even going one step further, integrating our systems and networks with their application solutions."

DEC's alliances

Over the past three years, DEC has been building alliances with OEMs and applications software firms. Some of the most noteworthy include: ASK Computer Systems, which makes software for Manufacturing Resource Planning (MRP) applications; Biles and Associates, which makes real-time database software that detects process conditions such as temperature, pressures and flow rates; Consilium Associates, which makes software that runs thin film and other semiconductor operations; and, two giants in factory automation, GE Fanuc Automation N.A. and Honeywell Inc., two systems-marketing partners that will sell DEC's VAX computer systems and develop VAX interfaces to some of their own products.

DEC is interested in business only where DEC systems can play an important role

In addition to partnering efforts, DEC now has four Solution Integration Centers across the United States — in Georgia, Connecticut, Michigan and California. These offer what DEC calls its Manufacturing Systems Integration Service, or MS/IS.

The strategy of selling solutions with hardware is not exclusive to DEC. It's no secret that IBM and HP also covet systems control in the factory, and that they are fitting rivals to DEC. In fact, on the service side of the business, excluding hardware or software sales, the scales are tipped in IBM's favor. The domestic market vided by computer companies totaled $58 million last year, according to a report by research firm Automation Research Corp. (ARC), in Medfield, Mass. And IBM topped the heap with a 34.4% share, followed by DEC with a 25.8% share and HP with 12.4%.

IBM is also the clear leader in personal computers on the factory floor, says Andrew Chatha, president of ARC. And that presence is expected to expand. Once Big Blue ruggedizes its PS/2 computers, they will go head to head with DEC's MicroVAX small computer, predicts Chatha, who also estimates that "IBM will sell far more PS/2s than DEC will sell MicroVAXs."

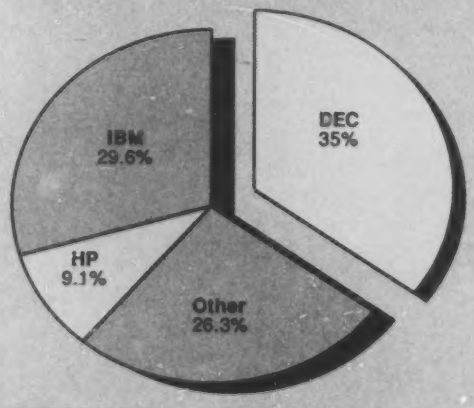
Although an installed base of boxes can be a great lever in winning CIM contracts, it is not the real key. The heart of CIM is integration, Chatha says, and DEC's networking capability is its "ace in the hole."

In the HP-versus-DEC confrontation, HP will have an uphill battle, says Irvin Krause, national partner for CIM at accountancy Coopers & Lybrand in Boston. In listing some HP strengths, Krause notes that HP does a lot of teaching and training, and opens its plants to let clients see how HP itself automates. And he explains that the company has well-entrenched niches where they are favored, such as in inspection, test and lab-type operations. "It will be interesting to see how HP defends its niches," he concludes.

CAROL SUBY

DEC dominates the market for computers and peripherals used in CIM applications...

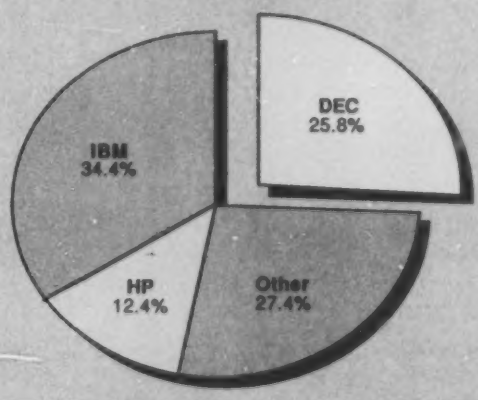
1986 shares of the $5.9 billion domestic market:



Source: IDC/CIMdata Inc.

...but trails Big Blue in systems-integration services:

1986 shares of the $58 million domestic market for services provided by computer vendors:



Source: Automation Research Corp.

CAD/CAM

CAD/CAM suppliers to the Navy: Send us a signal

A proposed multibillion-dollar purchase by the Navy could have effects far beyond its sheer size — if it proceeds

Early this year, the CAD/CAM industry was abuzz with talk of a planned multibillion-dollar Navy procurement. Potential vendors, drooling over what some said would be the single largest order ever for design automation software running on engineering workstations, were putting together infrastructures for bidding and flirting with potential partners. But now there is some question as to whether or not the procurement will get the go-ahead, which leaves CAD/CAM vendors puzzling over how to go after this potential prize.

Over the last 18 months, the Navy sent out to the industry two separate requests for information (RFI) to help it figure out how to automate its 40,000 engineers in computer-aided design, manufacturing and engineering. The second RFI ran to two volumes and 1,500 pages, and laid out a very ambitious plan for integrating everything from ship design to integrated-circuit design to documentation, all on tightly networked 32-bit Unix workstations. In February, some 50 vendors met at a Navy CAD users group, and speculation then was that a request for proposal (RFP) for bids would be out in midsummer.

None has emerged, and the latest expectation is that there will not be one until March, at the earliest.

> "It's going to be the largest thing coming out to the CAD/CAM industry next year"
>
> William Salter of Intergraph

When, or if, it comes out, it may be drastically different from the original plan. The original manager of the project, Capt. Joseph Callahan, then of the Navy Sea Systems Command, retired and has not been replaced. And the Navy says it won't talk until the RFP is out.

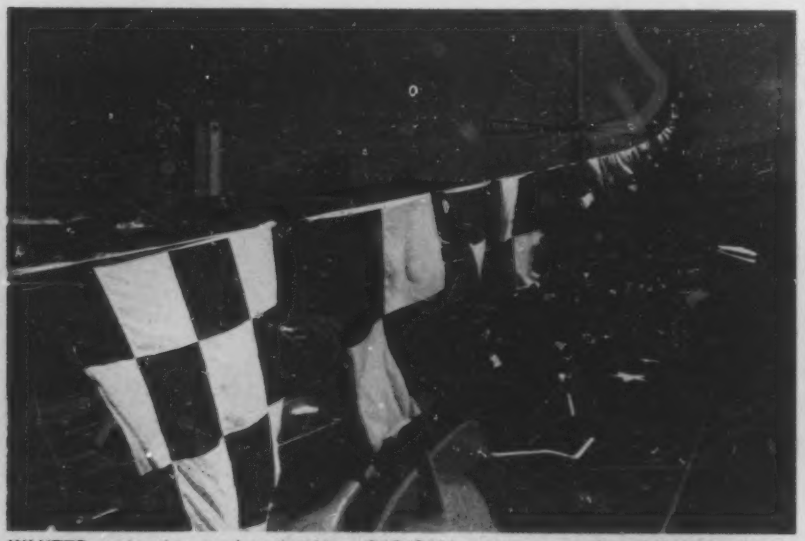
Who cares? Everybody

The award is important for two reasons. First, the procurement is big enough to tempt CAD/CAM vendors, workstation makers and even traditional military heavyweights. "It's going to be the largest thing coming out to the CAD/CAM industry next year," says William Salter, vice president for CAD/CAM supplier Intergraph Corp.'s federal business. He estimates that the Navy could buy $2 billion worth of systems over the next five years, including $150 million to $200 million in electronics design. "It's large enough that EDS and people like that — maybe even the Digitals of the world — would be interested," Salter says. Adds Steven Burrows, major accounts manager for CAE maker Mentor Graphics Corp.: "Various contractors will standardize on what the Navy buys. You could assume a total value three or four times over what the Navy purchases."

Second, and maybe more important to the CAD/CAM industry, is that the Navy is demanding networking and data transfer standards, some of which are still being developed by The Institute of Electrical and Electronics Engineers Inc. committees and others. And it wants to integrate what until now have been disparate design disciplines. "If it's successful, it will go a long way toward standardizing the CAD/CAM industry," Intergraph's Salter says. "It will force a number of the vendors to look a lot alike in products."

Even IBM says the Navy is "the biggest driver of standards," but that is a "good news, bad news" kind of proposition, according to Robert Tiel, director of marketing for electronics design in IBM's Information Systems Group. "It is a big opportunity, but the RFI is somewhat challenging," Tiel says. Matching up with what the Navy wants in the way of the Unix operating system "is pushing all the vendors, particularly us," he admits. But IBM is definitely interested — some of its "key accounts show a similarity to the Navy" in their demands, Tiel says.

If IBM wins the contract, according to Charles Foundyller of market researcher Daratech Inc., "Then all of CAD/CAM could go into one garden patch." Daratech ranks IBM No. 1 in the business already, with 25.5% of 1987 world sales of CAD/CAM equipment. Intergraph is second, with a 15.3% chunk of the $4.5 billion market. If IBM doesn't win, whoever does could get instant market share. "With things like the Navy contract,



WANTED: a signal to vendors that Navy CAD/CAM procurement will go full steam ahead

we could displace people," says Malcolm Davies, a vice president at Calma Co., the General Electric Co. CAD subsidiary which Daratech ranks a distant fourth.

To RFP or not to RFP

Industry observers theorize that a combination of internal squabbling in the Navy and grousing by potential suppliers may have already killed the plan. "The program on the table, as far as we're concerned, doesn't exist anymore," says Carol Bartz, vice president of the Federal Systems Division at workstation maker Sun Microsystems Inc. "The vendors just don't know what will happen."

The RFI was put together by Sea Systems Command, even though it calls for a five-part procurement by four other Systems Commands. "The other Commands may be saying, 'If it is over all five Commands, what is Sea Systems doing in charge of it?' " speculates Nina Lytton of industry watcher, The Yankee Group. Such "shilly-shallying" by the Navy might end up forcing the procurement up to the level of the Department of Defense, which would start the process all over again, she says. Lytton adds that Sea Systems did a "bang-up job" on the RFI.

Apparently, the Government Accounting Office agrees. Some vendors took a deep breath recently when the GAO announced it was looking at the procurement. The spending watchdog studied technical aspects of the proposal, an unusual step, and interviewed potential vendors to see if what the Navy wanted was feasible. Intergraph's Salter says his company was surveyed. One of the GAO's technical assessors, Kenneth Buckley, says he can't really disclose what the investigation showed. "The one thing I will say," Buckley says, "is that the Navy specifications are very well done. It is a visionary document."

Maybe too visionary. David Owens, director of marketing and business planning for Lockheed Corp.'s CAD subsidiary, Cadam Inc. says the Navy tried to convince Lockheed's Information Systems Group to make a bid for the whole package. "Lockheed actively hired consultants and spent two or three months taking a good hard look at it," Owens says. "They decided maybe the worst thing possible to do was win the Navy business, because it was a very blue-sky spec." Lockheed didn't want to get locked into the Navy's vision of the future of CAD. Cadam's point of view could be important, as its products are resold by IBM and 78% of IBM's CAD/CAM sales include Cadam equipment, by Owens' estimates.

Throwing weight

The analysts and some of the potential bidders hint that big hardware companies might be throwing a little weight around in Washington. A later RFP would allow Digital Equipment Corp., Hewlett-Packard Co. and IBM to firm up their workstation and Unix efforts. Daratech's Foundyller has an opinion on DEC's chances in any Navy competition: "The thing that kills DEC is the Unix requirement," he says. DEC's version of Unix costs its computers some performance when compared to its proprietary operating system, he adds.

> Maybe more important to the CAD/CAM industry is that the Navy is demanding networking and data transfer standards

Lytton, of The Yankee Group, also points out that the specs call for an "open" 32-bit bus. Data must be transferred across a bus for which statistics are published, and DEC's 32-bit bus is proprietary, she says. And much to IBM's chagrin, "the word mainframe is not mentioned in the entire RFI," Lytton adds.

Hewlett-Packard is arguably the furthest along in adopting industry standards, but HP CAE marketing manager Mark Tolliver says the RFI already accounts for "delayed deliverables" — products in the pipeline — that should come along naturally in the fast-paced workstation and CAD worlds. He specifically points to hardware pricing and advanced database manipulation as areas the Navy is willing to forgive a little on, for the time being.

But it all may come down to ships versus automation. "You know, a billion dollars is half an aircraft carrier," says Mentor's Burrows. One potential supplier, who prefers anonymity and used to work for the Navy, says, "Only one out of 10 admirals will be standing up for automation. All the others will be saying, 'I need ships, I need aircraft, I need facilities.' "

DAVID CARD

A proposed Navy contract could mean the biggest CAD/CAM deal ever

Estimated revenue for Navy CAD/CAM ($ millions)

	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993
Workstations	$32	$45	$65	$94	$135
Software	32	52	86	146	240
Peripherals	12	18	28	45	75
Service	11	18	33	63	113
Total	$87	$133	$212	$348	$563
Cumulative total	$87	$220	$432	$780	$1,343

FY = U.S. government fiscal year

Source: Dataquest Inc.

EUROPEAN ELECTRONICS

En garde, Uncle Sam! Europe is ganging up

Big Government failed to build a strong electronics base in Europe. Now let's see what the industry can do

By Jack Gee

Consolidation is the watchword this year for Europe's electronics companies. To withstand increasingly bitter international competition they are joining forces with rivals on their own continent and in the United States and Japan. Mergers, alliances and joint ventures are announced almost every week. These reflect new strategies by the old continent's manufacturers as they struggle to defend and expand market shares in components, computer systems and telecommunications.

"It's a crucial question of economic strength," says Pierre Braudé, an electronics industry consultant based in Paris. "Bigger companies with deeper pockets and wider product portfolios can survive better than their smaller brethren."

Edward M.A. Mier, director of market research firm Dataquest's European Telecommunications Industry Service in London, remarks: "With investment in a new public office switching system starting at $1 billion followed by ongoing annual expenditure of $1 million a year, there is only one way for European companies to achieve critical mass and economies of scale. That means mergers and partnerships."

Europe's electronics companies have come together before under government-sponsored research projects, such as the Esprit and Eureka programs. But tardy progress on such pan-European projects clearly is encouraging these participants to take matters into their own hands by letting market forces, not governments, dictate their success.

Bigger production and marketing units are being created against a backdrop of lackluster economic performance in the European countries. According to the Organization for Economic Cooperation and Development, (OECD) which groups together the Western world's 24 most prosperous nations, growth in Europe is unlikely to exceed 2% this year. This will be inadequate to make a dent in unemployment, which keeps 12% of the workforce idle.

OECD, based in Paris, points out that the U.S., with an increase of 33% in real economic growth over the past eight years, and Japan, with 17%, are constantly outpacing Europe's limping 12% growth. During this period, Europe has recorded virtually no net increase in jobs.

Consolidation is the watchword this year for Europe's electronics companies

While Britain, Italy, Spain and Portugal show respectable growth rates, they are achieving these from low base levels. Social and economic policies inherited from the early years after World War II are still smothering entrepreneurship and undermining market forces. Throughout most of Western Europe, politicians still lack the courage to sweep aside structural rigidities and cut Big Government down to size. And macro-economic policies among members of the 12-nation European Community — and most particularly in the linchpin economy of West Germany — remain excessively restrictive.

However, many European electronic companies are belatedly coming to grips with the realities of business life. Often, this apprenticeship is a hard school after decades of government protection which, while sheltering their businesses at home, has excluded them from foreign markets. Not surprisingly, Europe's high-tech success stories are to be found among companies such as Italy's Ing. C. Olivetti & Co. and West Germany's Nixdorf Computer AG, which have prospered without government support. Others, such as ICL Ltd., Britain's flagship computer maker, have largely shed their previous roles as cossetted "national champions." Today, they are proving they have the stamina to prosper in a competitive environment.

Nixdorf is one of the few European companies that prides itself on steering clear of the merger race. Chairman Klaus Luft, who took over the presidency after the sudden death of Heinz Nixdorf last year, has repeatedly denied that he would welcome a bigger partner in order to become a major foreign player in the U.S. market. Luft says: "Of course, Nixdorf could increase sales volume simply by buying brand names. However, we prefer to maintain our corporate culture and to train and hire more people of our own."

Europe's biggest electronics shakeup this year followed ITT's decision to withdraw from its far-flung, $6 million a year telecommunications equipment business. Control has now shifted to France's Compagnie Générale d'Electricité, which was returned to private ownership this summer after five years under state control. The telecom activities of ITT

Greg Couch

Late but in earnest: Europe's electronics industry is coming together to challenge Japanese and American dominance

and CGE have been pooled in a new company, Alcatel N.V., in which CGE has a 55% stake while ITT retains 37%. The remainder is owned by Belgian and French partners.

Georges Pebereau, a French electronics veteran who was chairman of CGE during the negotiations to create Alcatel, was determined to join forces with either ITT or ATT. He recalls: "I told Rand V. Araskog [ITT's chairman] it would be impossible for ITT and CGE to compete separately against AT&T, Siemens, Ericsson and the rest. We had to find a way to cooperate." To hedge his bets, Pebereau delivered the same message to AT&T.

At the end of the bargaining, the French government, as CGE's owner, ruled in favor of a partnership with ITT. "It is a very good deal for France," says Alain Madelin, the French Minister of Industry. That has yet to be proven. Meanwhile, the merger has completely redrawn the structure of the international telecommunications industry. It leaves Pierre Suard, the Frenchman who now heads CGE, addressing the same problems that daunted ITT. The Alcatel venture, with 30 subsidiaries operating in 79 countries and $13.4 billion in annual revenue projected for this year, ranks behind AT&T as the world's second-biggest telecom company. Worldwide sales and rental of AT&T's telecommunications equipment came to $16 billion in 1986.

The president of a major competitor says: "If CGE can rationalize ITT's operations, it will have powerful world presence. But it will be very difficult to make the merger work." Among the problems confronting Suard is how to restore the confidence of telephone operating companies in the trouble-ridden System 12 public office switch inherited from ITT. Dataquest's analyst, Mier, says: "ITT really had little choice. Without that merger, its telecom business would have [been in dire straits]."

ITT says it also intends to sell its 23.9% stake in Britain's STC Plc, the last relic of its European presence in telecom. However, ITT is waiting for

a good price. Daniel Weadock, ITT executive vice president and president of ITT-Europe, which is based in Brussels, Belgium, says: "Our STC holding isn't on the block with a for-sale sign."

ITT had planned to sell its STC holding to France's CGE with the rest of its telecom assets in Europe. But it dropped the idea when Lord Keith of Castleacre, the STC chairman, objected that CGE competed with STC in the telecommunications arena. STC, which is also looking for alliances, is expected to announce profit gains for 1987 and again in 1988. But the company is likely to encounter renewed difficulties as competition grows in the British market for the products of its core businesses: telecom products and the mainframe computers made by its subsidiary, ICL Ltd.

France's CGE and Britain's STC are not alone in scrambling to find international partners. STET SpA, a unit of the Italian state-owned conglomerate Istituto per la Ricostruzione Industriale, and Telefonica, Spain's state phone company, are preparing to pool their efforts in managing phone networks, introducing new technology and services, and developing telecom standards.

STET recently cleared a merger of Italtel SpA, its public office switching offshoot, with Telettra SpA, Fiat SpA's telecom unit. This joint venture, Telit, is not yet operating. But it is being courted by some of Europe's biggest telecom concerns, including West Germany's Siemens AG and Telefon AB L.M Ericsson of Sweden, which are also keen to become partners.

As a wind of change is blowing through Europe's hitherto highly regulated telecom business, Britain's fledgling carrier Mercury Communications Ltd. is seeking traffic agreements with firms in neighboring countries. Mercury, an offshoot of Cable & Wireless Plc, only recently began to compete at home with British Telecommunications Plc. Soon, under an arrangement with Italy, it intends to charge up to 17% less than British Telecom for traffic between the two countries. Gordon Owen, Mercury's managing director, has already established reciprocal arrangements with carriers in the Australia, Canada, Singapore and the United States.

Meanwhile, two British electronics giants, General Electric Co. (not related to GE in the U.S.) and The Plessey Co. announced recently that they intend to merge their telecommunications activities. The proposed 50-50 joint venture, which will start with nearly $1.9 billion in revenue, will handle public switching, private switching, transmission and the System X digital exchange.

France's Thomson S.A. group is cementing its own electronics empire with a series of alliances and acquisitions. It has merged its nonmilitary semiconductor business with that of SGS Microelettronica SpA, a member of Italy's STET group. Thomson's president Alain Gomez, a former paratrooper and Harvard graduate

The changing scene across the Atlantic will require U.S. firms to review their strategies to safeguard their own businesses

who two years ago masterminded Thomson's acquisition of Mostek in the U.S., says: "This is the only strategy for survival."

Robert Heikes, cofounder of European Silicon Structures, the fast-turnaround custom chip venture in which half a dozen of Europe's most prominent high-tech firms have invested, says: "It would make sense for Britain's Plessey to make up a semiconductor trio with Thomson and SGS." Thomson officials say there have been contacts with Plessey and do not rule out its entry into the Italo-French partnership.

In passive components, Thomson is cementing its position by turning to Asia. The French group's Thomson-CSF subsidiary has signed up with Daewoo, the South Korean industrial conglomerate, to manufacture soft ferrites. These will be sold to the consumer electronics factories of Philips and America's General Electric Co., as well as those of the two founder partners in Asia.

Earlier this year, Philips and Britain's General Electric Co. merged their medical-electronics imaging businesses to create the biggest diagnostic imaging company in Europe. Now, Thomson has agreed in principle to exchange its assets in medical electronics for those of U.S. General Electric Co. in consumer products. This deal is due to be finalized in November. Thomson has also paid Britain's Thorn-EMI $145.8 million for its television and other electronics brown-goods operations. Thomson's Gomez says: "Consumer electronics will remain, alongside defense and professional electronics, a core business for us. We are now firmly entrenched in the leadership of Europe's consumer products. In fact, we are neck and neck with Philips. Only Matsushita lies ahead of us."

Philips is also reorganizing its world-girdling empire. The Dutch multinational is currently taking over the 42% of North American Philips Corp. that has until now remained outside its control. The buy-out involves such famous U.S. brand names as Genie, Magnavox, Philco and Sylvania. Cornelis van der Klugt, Philips' chairman, comments: "We will now be one unified company and better able to compete on a global basis."

Megaproject

Philips biggest joint venture is Megaproject, a partnership with Siemens AG in developing the semiconductor chips of the future. Almost $1 billion has been invested in this effort by the two companies and by the governments of the Netherlands and West Germany. Philips' mission is to make a one-megabit static random access memory chip, which will have applications in consumer electronics, communications and automobiles. Siemens is developing a 4Mb dynamic random access memory chip which stores four times more information but is slower and consumes less energy.

As it monitors the strategies of competitors such as Philips and Thomson, Siemens is studying new mergers of its own. Last year, the West German giant absorbed GTE Corp.'s U.S. transmission equipment business as well as switch manufacturing units in Italy, Belgium and Taiwan. However, the deal excluded GTE's big switches in the United States. Hermann Franz, group head of Siemens' microelectronics divi-

Europe's version of "Let's make a deal!"

A sampling of recent and planned link-ups involving Europe's electronics companies

Who's doing what...	with whom...	...and why
CGE (France)	**ITT** (U.S.)	A pooling of these companies' telecom activities forms the world's second largest telecom company, Alcatel N.V.
STET (Italy)	**Telefonica** (Spain)	These companies are working together in managing phone networks, introducing new technology and services, and developing telecom standards.
Italtel (Italy)	**Telettra** (Italy)	This joint venture is called Telit. Italtel is STET's public office switching offshoot. Telit is being courted by major European telecom companies such as Ericsson and Siemens.
Thomson (France)	**SGS Microelettronica** (Italy)	This a merger of nonmilitary semiconductor businesses.
Thomson-CSF (France)	**Daewoo** (Korea)	These companies have agreed to manufacture soft ferrites for consumer electronics products.
Philips (Holland)	**GEC** (Britain)	This merger of medical-electronics imaging businesses forms the largest diagnostic imaging company in Europe.
Thomson (France)	**GE** (U.S.)	Thomson's medical-electronics assets are being exchanged for GE's consumer electronics products.
Thomson (France)	**Thorn-EMI** (Britain)	Thomson paid Thorn-EMI $146 million for its TV and other electronics brown-goods operations.
ITT (U.S.)	**STC** (Britain)	ITT is seeking to sell its 23% stake in STC.
Philips (Holland)	**North American Philips** (U.S.)	The Dutch multinational is taking over 42% of the U.S. company that has, until now, remained outside its control.
Philips (Holland)	**Siemens** (W. Germany)	This joint R&D program, called "megaproject," is aimed at developing the chips of the future, including a 4-megabit DRAM. To date, the partners and their national governments have invested almost $1 billion in the project.
Siemens (W. Germany)	**GTE** (U.S.)	Siemens bought GTE's U.S. transmissions equipment business, plus its switch-manufacturing units in Italy, Belgium and Taiwan. The deal excluded GTE's big switches in the U.S.
Ericsson (Sweden)	**Matra** (France)	The two companies have agreed to develop, produce and market new digital phones for a European mobile-telephone network. They are also jointly taking control of former ITT offshoot CGCT.
Groupe Bull (France)	**Honeywell** (U.S.) **NEC** (Japan)	This three-way joint venture forms Honeywell Bull, which is specializing in installing computer networks and selling midsized computer systems serving groups of up to 150 users.
Brown Boveri (Switz.)	**ASEA** (Sweden)	This merger of main operating units forms the world's largest heavy electrical engineering group. The focus is on factory automation, plus planned joint developments in superconductors.

Source: ELECTRONIC BUSINESS

sion, says: "We are constantly asking ourselves whether we have achieved optimal size." Last year, Siemens' sales of semiconductors totalled $360 million, compared with joint sales for Thomson and SGS of $760 million. Franz comments: "Clearly, mergers are a logical strategy." But, although Siemens is frequently approached by potential partners, no serious negotiations appear to be going on at present.

Electronics veteran Heikes, who has run the European semiconductor operations of National Semiconductor Corp. and Motorola Inc., comments: "Siemens does not appear to have a clear strategy in semiconductors at present. They are at a low point in their cycle. With SGS and Thomson now together and Philips faring well on its own, it is difficult to see who in Europe could make up an effective team with Siemens."

Sweden's Ericsson, which has gone head-to-head with Siemens in the contest for public switching orders from America's Bell companies, is also trying to expand its European market. With this target in view, Ericsson has joined forces with Matra, the French electronics and defense group, to take control of Compagnie Générale de Constructions Téléphoniques, an ailing offshoot of ITT which was nationalized five years ago.

The French government's choice of the Ericsson-Matra consortium in a contest against bids from Siemens and a partnership between Philips and AT&T provoked a storm of protests from both the Netherlands and the United States. The deal gives Ericsson immediate access to 16% of the French public switching market, with hopes of a bigger slice later. Ericsson and Matra have also agreed to develop, produce and market new digital phones for a European mobile telephone network.

France is particularly active in restructuring its electronics industry. The gradual return to private ownership of state-managed companies is presenting these with new challenges and opportunities. Groupe Bull, the French flagship computer manufacturer which still awaits privatization, has joined in a three-way joint venture, Honeywell Bull Inc., in which Honeywell Inc. and Bull each hold a 42.5% stake. Japan's NEC Corp., which supplies the two U.S. and French firms with their large mainframes, holds 15%. Within two years, Bull could exercise an option to buy 53% of Honeywell's share in the joint venture.

Based in Minneapolis, Honeywell Bull will specialize in installing computer networks and selling mid-sized systems that serve groups of up to 150 workers. Jacques Stern, chairman of the new venture as well as of Groupe Bull, says: "A $5 billion company with a common strategy and commercial and R&D synergy is a very powerful force." However, industrial observers point out that the venture reflects France's awareness that its computer industry cannot survive without U.S. and Japanese products.

The future of Europe's electronics industry will also be influenced by the recent merger of the main operating units of Brown Boveri & Co. of Switzerland and Asea of Sweden. Together they form the world's biggest heavy electrical engineering group. Both also focus strongly on electronics. And over the past few years, they have become world league forces in factory automation. Percy Barnevik, Asea's president and the designated president of the new company, says: "Factory automation will be one of the major fields of our future development."

Barnevik also intends to embark on a big joint effort to develop superconductors, materials that, at low temperatures, conduct electricity with little or no loss of energy. Brown Boveri Asea will certainly slim down its current workforce of 160,000. But it expects to spend almost $1 billion on research and development and to register sales close to $9 billion.

After the honeymoon-style celebrations of their mergers, companies such as Thomson and SGS are discovering the problems of matrimony. But Europe is also experiencing the end of the era of fragmented markets, which made its manufacturers so vulnerable to competition. This changing scene across the Atlantic will require U.S. firms to review their strategies in order to safeguard their own businesses. ▷

Notes on the top European companies

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information has been converted at the exchange rates at the end of the accounting period.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe: for non-European companies, the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investments (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country of origin: Indicates the country in which the company is ultimately registered.

Top companies in Europe – 1986

Rank	Company	Electronics sales ($ millions)	Electronics as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$16,895	67%	$25,131	3.6%	2.1%	$73,013	$2,598
2	**IBM**	16,224	32%	51,250	16.4%	9.3%	127,011	20,790
3	**Siemens**	11,631	50%	23,261	6.5%	3.1%	64,081	4,181
4	**CGE ***	11,500	NM	11,674	3.2%	2.1%	84,484	2,688
5	**Thomson-CSF**	5,610	100%	5,610	7.8%	2.9%	145,901	11,336
6	**GEC**	4,979	59%	8,396	12.7%	8.0%	52,611	6,702
7	**Olivetti**	4,940	91%	5,452	9.8%	7.7%	92,268	9,085
8	**Ericsson**	3,659	78%	4,671	2.9%	1.8%	64,357	1,841
9	**Robert Bosch**	3,409	30%	11,268	6.7%	2.0%	76,456	5,157
10	**Digital Equipment**	3,253	35%	9,389	18.0%	12.1%	84,972	15,284
11	**STET-IRI**	2,840	26%	10,740	7.2%	4.7%	80,812	5,792
12	**Groupe Bull**	2,769	100%	2,769	1.9%	1.5%	103,312	1,917
13	**STC**	2,555	91%	2,823	6.9%	4.5%	74,645	5,181
14	**Rank Xerox**	2,555	26%	9,781	6.9%	5.0%	97,452	6,725
15	**Nixdorf**	2,336	100%	2,336	8.0%	4.9%	91,335	7,333
16	**Hewlett-Packard**	2,197	31%	7,102	11.0%	7.3%	86,610	9,512
17	**Plessey**	2,193	96%	2,288	12.9%	8.4%	71,586	9,223
18	**Racal**	1,902	92%	2,065	7.8%	5.0%	63,708	4,950
19	**Matsushita**	1,900	7%	28,067	9.6%	3.6%	206,555	19,914
20	**AEG**	1,816	31%	5,821	0.6%	0.0%	74,437	472
21	**Grundig**	1,769	100%	1,769	4.9%	3.5%	90,815	4,462
22	**Unisys**	1,750	24%	7,432	-1.2%	-0.6%	75,609	-934
23	**Sony**	1,718	21%	8,180	5.8%	3.2%	168,067	9,690
24	**Canon**	1,516	27%	5,523	3.1%	1.2%	155,589	4,857
25	**NCR**	1,350	28%	4,882	12.7%	6.9%	78,735	9,995
26	**Bayer**	1,238	5%	21,141	8.1%	3.3%	122,201	9,896
27	**Motorola**	1,000	17%	5,888	4.5%	3.3%	62,373	2,807
28	**Schlumberger**	1,000	22%	4,568	NA	-36.2%	91,992	NA
29	**Thorn EMI**	960	19%	5,096	5.0%	3.2%	68,567	3,434
30	**Ferranti**	960	95%	1,006	8.0%	5.0%	46,198	3,689

NA = not available

NM = not meaningful

* ITT's telecommunications activities, acquired on Dec. 30, 1986 are included in electronics sales, but are not included in 1986's consolidated sales. Balance sheet data includes ITT's former subsidiaries consolidated by equity method.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$1,503	$24,207	15.3%	6.1%	7.6%	7.7%	1.53	12/86	Netherlands
11,868	52,708	19.2%	18.6%	10.2%	9.0%	2.18	12/86	United States
2,009	13,621	22.1%	10.1%	11.5%	10.6%	2.22	9/86	West Germany
1,798	11,571	11.6%	5.4%	6.8%	4.8%	1.29	12/86	France
4,164	29,409	15.7%	21.1%	9.8%	5.9%	1.10	12/86	France
4,214	8,303	4.8%	18.1%	NA	4.8%	2.50	3/87	Britain
7,132	16,928	11.0%	11.7%	5.3%	5.7%	2.24	12/86	Italy
1,145	13,901	15.0%	4.2%	9.9%	5.2%	1.92	12/86	Sweden
1,513	11,670	12.9%	20.9%	5.1%	7.8%	1.34	12/86	West Germany
10,293	19,252	18.7%	26.0%	10.8%	8.0%	3.40	6/87	United States
3,801	169,362	36.1%	3.7%	NA	36.1%	0.83	12/86	Italy
1,573	34,769	22.0%	3.3%	7.7%	14.2%	1.60	12/86	France
3,347	12,293	15.4%	20.3%	8.3%	7.0%	1.61	12/86	Britain
4,862	25,516	17.2%	9.1%	6.6%	10.6%	1.80	12/86	United States
4,511	34,403	23.8%	11.3%	9.5%	14.3%	2.18	12/86	West Germany
6,293	27,268	18.6%	17.2%	11.6%	7.0%	2.51	10/86	United States
5,998	14,621	12.0%	21.5%	6.6%	5.4%	2.17	3/87	Britain
3,178	17,126	5.7%	13.6%	NA	5.7%	1.74	3/87	Britain
7,389	25,318	8.8%	15.7%	5.5%	3.3%	1.79	11/86	Japan
0	10,453	13.0%	1.0%	8.0%	5.0%	2.74	12/86	West Germany
3,194	12,401	9.9%	19.9%	3.4%	6.5%	1.25	3/87	West Germany
-442	22,301	13.4%	-2.3%	5.9%	7.4%	1.36	12/86	United States
5,313	42,186	16.3%	9.6%	9.2%	7.1%	1.55	10/86	Japan
1,877	40,493	15.4%	5.4%	6.2%	9.1%	1.58	12/86	Japan
5,427	15,489	13.6%	23.6%	6.2%	7.4%	2.01	12/86	United States
4,035	29,811	10.9%	17.7%	5.1%	5.8%	1.62	12/86	West Germany
2,055	24,047	18.0%	8.4%	8.4%	9.6%	1.63	12/86	United States
-33,318	36,900	18.3%	NA	8.5%	9.8%	1.64	12/86	Netherlands
2,207	17,563	11.9%	16.0%	1.7%	10.3%	1.11	3/87	Britain
2,315	8,730	5.9%	22.1%	NA	5.9%	1.39	3/87	Britain

Source: ELECTRONIC BUSINESS

DISPLAYS

Electroluminescence lights up in the flat-panel market

They'll hardly replace LCDs entirely. But EL displays are getting glowing reports from makers of laptop computers

Electroluminescence is another one of those "promising" technologies. The technique gives flat-panel displays the bright, crystal-clear images that portable computers have normally lacked, but it is costly and power hungry. At $29 million in world sales this year, EL displays made up only a miniscule portion of the $1.9 billion flat-panel display market, according to market watcher Stanford Resources Inc. But ELs make up the fastest-growing segment, and sales should go over $750 million by the mid-1990s.

Three different technologies are competing for flat-panel dominance, each with its own benefits and foibles. Liquid-crystal displays (LCDs) make up the largest market segment by far, with over $1 billion in 1987 sales. But these are "passive" displays; that is, they only reflect light so they can be difficult to read in poorly lit areas.

Gas plasma displays, which use high electrical current to make a gas glow, are one light-emitting technique; the other is EL, which uses high currents to produce light from a special coating on the screen. Both offer bright contrast, but they suffer from high power consumption — put one on a portable PC and you can forget about running the computer on a battery. Plus, they tend to cost twice as much as LCDs.

"One of the early complaints about laptops was the readability of the LCD. We got hit hard on that," says

> Sales of EL displays should go over $750 million by the mid-1990s

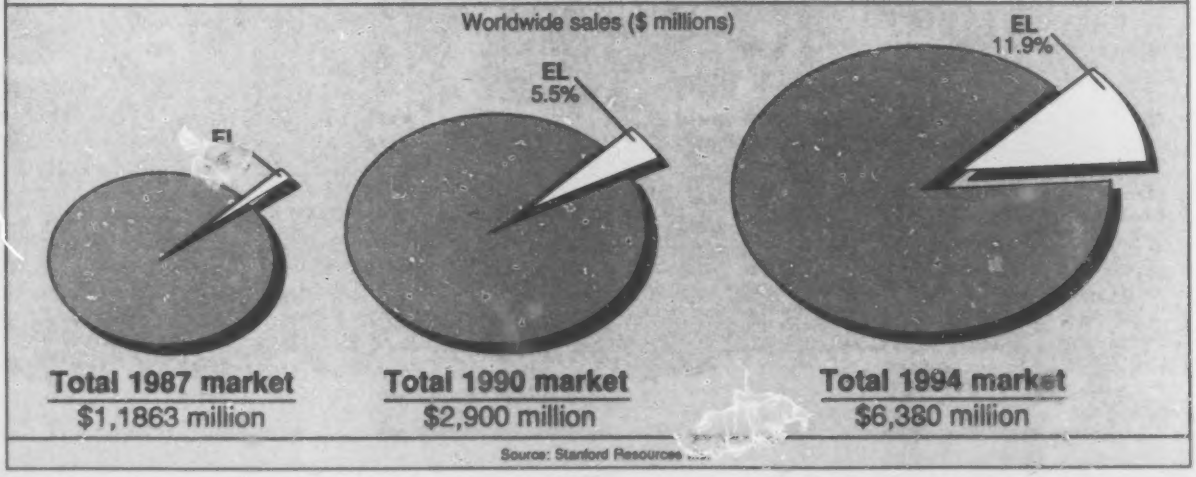
Barbara Nolan, product manager for Data General Corp.'s portables. So DG did a quick redesign a year and a half ago, and offered an EL display from start-up Planar Systems Inc. Nolan says DG looked at plasma — the choice of competitors like Compaq Computer Corp. and Toshiba Corp. — but liked EL's smaller size and lower power consumption.

Although there is a $1,000 price difference between DG's EL and LCD portable computers, Nolan says discriminating customers will swallow the extra expense. A large insurance company, for instance, whose agents have to make presentations to families in their living rooms, appreciates the wide angles of vision EL allows, she says. Still, EL models only make up a quarter of DG's portable sales. "We're happy with that 25%, but in all honesty, it was a little bit higher percentage before LCDs were back-lit," Nolan admits.

Besides putting a light behind the LCD, which adds little to power requirements, LCD makers are fighting back with two types of displays which give high contrast: "supertwist," a new method of assembling the glass layers; and "active matrix" displays, where electronic "driving" of individual picture elements gives superior brightness. "Supertwist won't be the death of EL, but active matrix displays will certainly put a large crimp in the EL marketplace," says David Matthews, national distributor sales manager for Sharp Electronics Corp. of Mahwah, N.J. Sharp makes both EL and LCD screens. Matthews says that the screens of active matrix displays, which so far have shown up primarily in those tiny 3-inch TV sets, will double in size next year.

DG's Nolan thinks that active matrix displays "still will not approach EL" in sharpness. Also, she says, any LCD technology tends to suffer from an "afterimage" effect, which means you can't use it, for example, in oscilloscope functions where the image is constantly moving. Nolan says that the first wave of portable PC buyers

Electroluminescence (EL) begins to shine in the flat-panel market



Source: Stanford Resources

were commercial users, but as technical buyers emerge, applications like instrumentation will take on significance.

Market research firm Stanford Resources gives Planar EL market leadership, by a hair, over Sharp; between them, these two own most of the market. The primary mission of Planar president James Hurd is to drive costs down at his Beaverton, Ore., company. So far, he's slashed the average selling price of his displays 40% a year for the past three years. He attributes much of this to lower component prices — particularly smart-power chips from Texas Instruments Inc. and surface-mounted components in general.

Also, "Planar is ahead of just about everybody" in finetuning its manufacturing process, according to Stanford Resources' researcher Joseph Castellano. Planar, spun off from Tektronix Inc. and partially funded by the instrumentation giant, is

LCD makers are fighting back with two types of displays that give high contrast

achieving near-90% yields on its panels, using a thin-film deposition technique which Hurd says is much like the process technology in the semiconductor industry.

Manufacturing EL displays is no easy task. Delays in starting up its manufacturing line cost Finlux Inc., the U.S. subsidiary of Finland's Lojha Corp., the chance to supply displays for Hewlett-Packard Co.'s portable, says Finlux president Ismo Linden. Instead, Sharp got that business. But Linden remains an HP fan — Finlux makes displays for a touch-screen factory-floor terminal built by HP's Panacom Automation division. Linden says he's looking for a corporate partner to help finance his production ramp-up.

Planar sells displays to its partner, Tek, for audio instrumentation, and also has a solid military business. N.V. Philips GL's Magnavox subsidiary makes a portable datacommunications terminal with a Planar screen, and the Navy plugs one into a Zenith Electronics Corp. PC aboard submarines. Planar also has a $2 million Army contract to develop color EL displays.

DAVID CARD

PERSONAL COMPUTERS

Factory PCs: Training to become better foremen

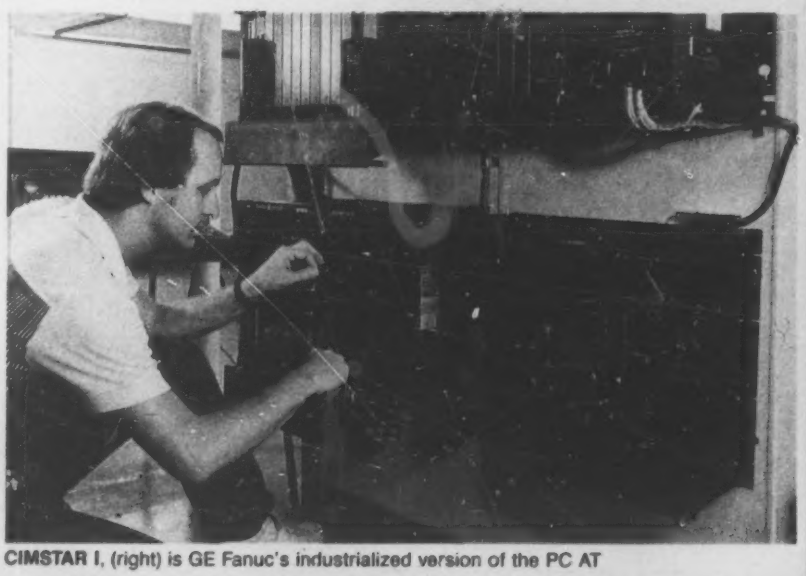
Increasingly, small computers are signing on for industrial control jobs. But don't look for PS/2s on the shop floor yet

Personal computers that are altered and given new model designations for harsh factory floor environments are showing up more and more in industrial control functions. But it's still a small market, possibly less than $15 million worth of shipments this year. And talks with major suppliers suggest it will be some time before IBM's second generation Personal System/2 computer will play a major role in the industrial environment.

"The industrial automation market still is in its infancy," observes Sam Meshulam, PC marketing specialist for Gould Industrial Automation Systems in Andover, Mass. "It's driven by applications, not hardware, so the PS/2 isn't producing a solution." When OS/2, the operating system developed by Microsoft Corp. of Bellevue, Wash., comes around and systems based on the 32-bit Intel 80386 chip proliferate, then "you'll be able to really start doing something, but that won't be for at least another two years," he adds.

Until then, companies that put industrial systems together will continue to use application programs geared toward first generation IBM PC AT and even PC XT applications software. San Diego-based Action Instruments Inc., which is widely acknowledged to have pioneered PCs for use in industrial environments, will introduce an 80386 version of its A-PAC family of industrial PCs in December or January. But it will be compatible with the AT. "It's the safest approach," says president James Pinto, "because the industrial market for PS/2 technology is zero."

Beginning in 1982 with a Z-80 chip version of a personal computer that was "hardened" to resist vibration, higher temperatures and electromagnetic interference environments on the factory floor, Action has brought out computers that were compatible with the XT and AT. Last year it introduced the BC-22, an AT version which is being sold as the Cimstar I by GE Fanuc Automation North America Inc., a subsidiary of a $200 million joint venture between General Electric Co. and Fanuc Ltd. of Japan. Action also sells its BC-22 through an original equipment manu-



CIMSTAR I, (right) is GE Fanuc's industrialized version of the PC AT

REAL ESTATE

Tearing up the "For Sale" sign

As the industry regains its earlier vigor, more and more firms are gradually expanding commercial operations

By Theresa Engstrom

The electronics industry, which has *not* invested heavily in new plants and equipment during the past three years, may be on the verge of a new spending cycle. It may not be the boom of the early 1980s, but it could be a boom, nonetheless.

That's good news for commercial realtors. "The industry has bottomed out, and we are starting to see more activity," says Alan Beaudette, vice president and national director for marketing of industrial products for Coldwell, Banker Commercial Group Inc. Nobody is denying that the past six years have been dark ones: Nationally, since 1980, employment in high-technology companies has increased only slightly more than the national job growth rate of 2.4%, according to Grubb & Ellis, a San Francisco market research firm.

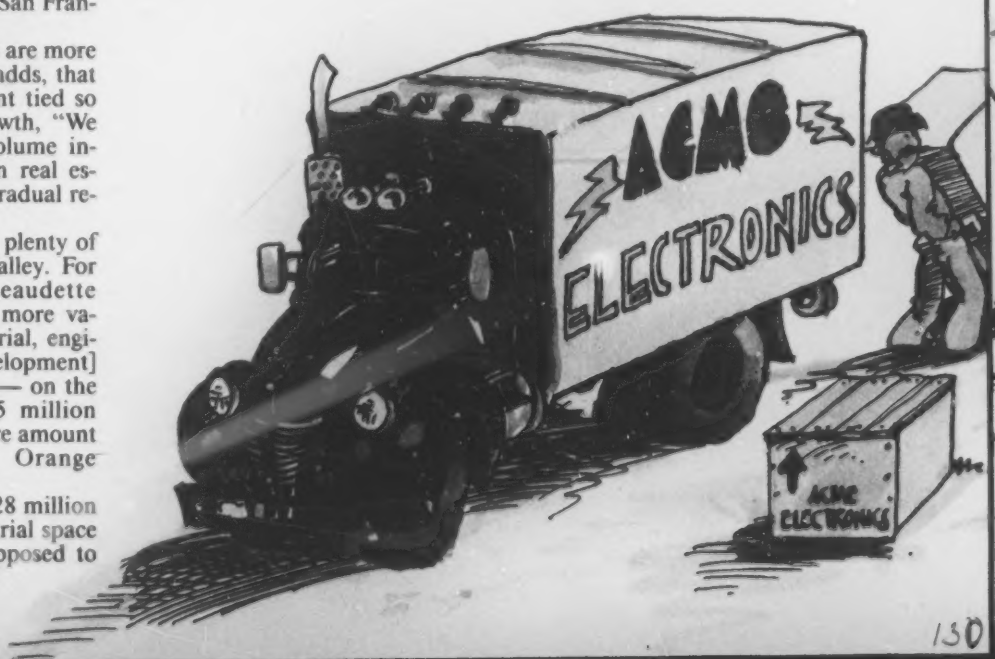
But real estate developers are more optimistic now. Beaudette adds, that with real estate development tied so closely to employment growth, "We won't see a tremendous volume increase [in electronics-driven real estate activity], but rather a gradual rebuilding process."

For starters, there is still plenty of space left in the Silicon Valley. For comparison purposes, Beaudette points out that, "There is more vacant high-tech [light industrial, engineering, research and development] space in the Silicon Valley — on the order of 30 million to 35 million square feet — than the entire amount of high-tech space in Orange County."

The fact that there were 28 million square feet of vacant industrial space in San Jose last July, as opposed to 31 million square feet a year earlier, indicates probable signs of slow rehabilitation. Yet, it also indicates that there is very little new space coming on the market. This may be grim news for developers, but good news to electronics companies, as there are "tremendous deals to be made, all over California," according to one commercial realtor. In some areas, light industrial space is being leased at a 40% less than 1985 prices, says Carl Blanke, senior vice president and branch manager of the San Jose office of Cushman & Wakefield, a commercial real estate firm.

However, the high-tech real estate business is not yet blooming in the Valley. Even where there is hopeful talk of expansion, a closer inspection often shows that contraction, and not expansion, is actually taking place. National Semiconductor Corp., for instance, recently leased two and a half buildings near the San Jose airport. But the move was hardly an expansion; the buildings will be the new home for National's information systems group, which is being brought together under one roof from several other locations. "This sure isn't the time to talk about expansion," a spokesman for the Santa Clara company says.

Outside of northern California, however, it's more difficult to make such blanket statements. At the other end of the country, in New England, some companies have held up well during the recession and show no



Jon McIntosh

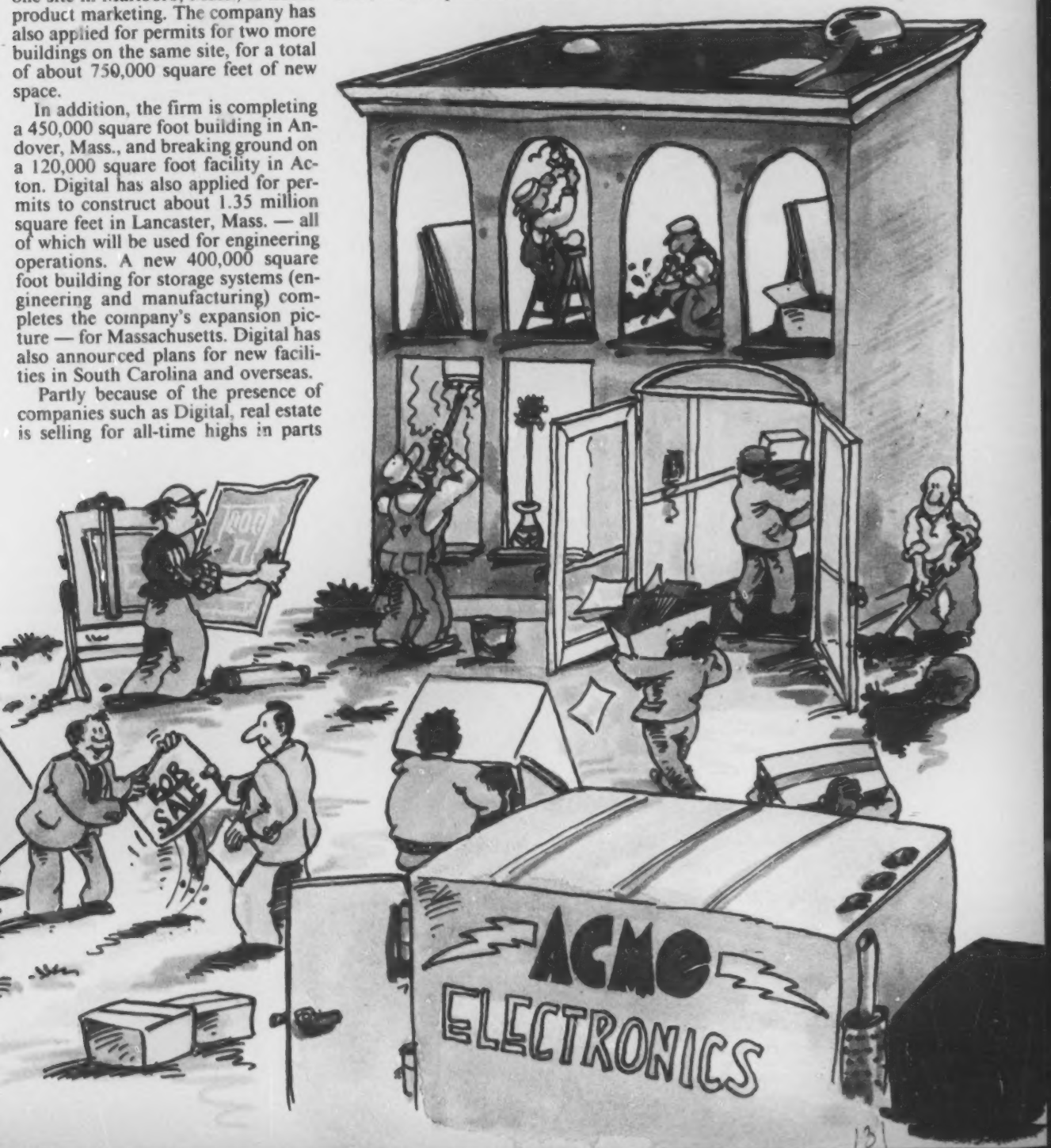
signs of slowing down. In fact, observers of Digital Equipment Corp. might wonder what all the talk of recession is about.

Growth in New England

Digital, which employs about 30% of its 110,000 people in Massachusetts, is building a fourth building on one site in Marlboro, Mass., to house product marketing. The company has also applied for permits for two more buildings on the same site, for a total of about 750,000 square feet of new space.

In addition, the firm is completing a 450,000 square foot building in Andover, Mass., and breaking ground on a 120,000 square foot facility in Acton. Digital has also applied for permits to construct about 1.35 million square feet in Lancaster, Mass. — all of which will be used for engineering operations. A new 400,000 square foot building for storage systems (engineering and manufacturing) completes the company's expansion picture — for Massachusetts. Digital has also announced plans for new facilities in South Carolina and overseas.

Partly because of the presence of companies such as Digital, real estate is selling for all-time highs in parts of New England. Along legendary Route 128, the "technology highway," electronics manufacturers can no longer afford the rates. "It's almost unfeasible to do warehousing or manufacturing on 128," says Brune Levering, vice president and manager of Coldwell Banker's suburban Boston office in Wellesley, Mass. That area, where space now rents for $24 to $28 a square foot, "has matured into a strictly first-class office market," he says. Massachusetts companies are now looking farther afield, along Route 495, some 30 miles outside of Boston, or in southern New Hampshire. "Digital, Raytheon, Prime Computer, Wang Laboratories, Apollo Computer, Sequoia, Proteon and Codex . . ." says Levering,



ticking off a list of Massachusetts electronics companies that are expanding or at least doing well. "The hits just keep coming." New England is certainly not an unqualified success story. But with a 3.1% unemployment rate (as of late summer), it's getting harder to find electronics firms that have fallen on hard times.

East is East

Yet, the difference between East and West is not just an accident of geography; it is more closely tied to the fact that some sectors — such as semiconductors vs. minicomputers — have been harder hit than others. Defense contractors, many of which are concentrated in New England, Southern California, the Pacific Northwest and on the eastern seaboard between New York and Virginia, have been riding an eight-year wave. For them, geography is largely incidental. Ford Aerospace and Communications Corporation, for instance, was awarded $1.7 billion in contracts last year, an increase of $385 million over the previous year. Ford's Western Development Laboratories division recently acquired four buildings in the Golden Triangle Corporate Center near San Jose, a total of 546,000 square feet. The company also bought an adjacent vacant piece of property, which will headquarter the division sometime next year. Western Development Laboratories, a leading designer of communications and weather satellites, has been largely immune to the problems that have afflicted its neighbors in Santa Clara County.

On the other hand, some geographic areas haven't been able to shake off their lethargy, no matter what type of industry they boast. Referring to vacant real estate property, Beaudette says that, "in the oil patch [Texas and Louisiana], there's a tremendous oversupply."

In a recent survey of commercial real estate activity, Grubb & Ellis ranked San Antonio, Texas, last out of 28 metropolitan areas for speculative industrial construction, with an estimated zero percent growth in new building. (Los Angeles was highest, with an estimated 1.9% growth over its existing base, for 7.9 million square feet of new space.)

"Last year when I talked with electronics companies down here, all I got was glassy-eyed stares," drawled one Texas development official, who asked not to be named. "At least this year I think they've blinked once or twice."

Elsewhere around the country, smaller markets are making a name for themselves

Infomart, the big Dallas technology market developed by Trammell Crow, has rented about half of its 880,000 square feet of "leasable" space, according to Michael Weinnig, vice president for corporate systems and services. While he wouldn't say if that figure represented an increase over the year before, Weinnig did say that the mart is "seeing renewed activity." AT&T and Xerox Corp., two of Infomart's tenants, have either expanded recently or are exploring the possibility, says Weinnig.

Elsewhere around the country, smaller markets are making a name for themselves. Last year, the greater Washington, D.C., area — not traditionally considered an electronics mecca — employed 13,000 people in the computer industry, and 34,000 in "high tech," according to Grubb & Ellis. (The firm defines high tech as any industry with above average R&D spending; above average proportion of technical, engineering and/or scientific jobs; above average growth in manufacturing employment since 1980; significant industry employment in multiple locations; industry primarily making product, not just using product; and with a product cycle less than 15 years old.)

Partly because of its smaller base (34,000 employed in "high tech," compared with 234,000 similarly employed in San Jose), Washington, D.C. experienced the fastest high-tech employment growth rate among 28 major metropolitan areas, an 11.6% increase between 1980 and 1986, according to Grubb & Ellis.

Rate pressure

While this has encouraged investment in industrial space, it has also put some upward pressure on rates. Last year, rental rates of $9 per square foot weren't unusual in Washington for warehouse and manufacturing space; $12 was common for research and development facilities (compared with the $4 price found in many other areas).

"We don't see an oversupply in D.C.," says Beaudette, who allows that "most major electronics companies have a presence in that area." Part of the attraction, he adds, is the perceived "quality of life," as well as a good transportation network, a wealth of blue- and white-collar labor, and proximity to the European market via the eastern seaboard.

Another name that crops up frequently is Florida. Downtown Boca Raton is a boomtown, with many smaller firms swimming around the anchor, IBM. Both Tampa and Orlando are considered "emerging centers," as are other sites around the country, such as northern New Jersey; Colorado Springs; Salt Lake City; and the desert cities of Albuquerque,

How much is high tech?

The numbers tell the story: In Santa Clara County and its surrounding environs, "high tech" absorbed about 11.5 million square feet of space in 1985; that figure rose to 12.9 million in 1986; and for the first half of 1987, it was looking still healthier at 7 million square feet, according to figures compiled by Cushman & Wakefield of California.

And the major markets — which Beaudette identifies as Southern California, suburban Boston and Washington, D.C. — are doing fine, thank you.

"It won't be a slam-dunk recovery," says Beaudette. But electronics companies who are starting to think again about expansion after the long dry spell will find a plentiful amount of space and soft prices await them when they finally do make their move. □

N.M., and Tucson, Ariz.

"Raw materials used to be an important factor in a company's decision to locate somewhere," says Beaudette. "But today the quality and type of labor is much more important."

Labor, in fact, has given rise to the "maquiladora" (Spanish for twin plants) phenomenon, whereby a company locates one plant on the Mexican side of the border and a sister plant on the American side. Manufacturing is conducted on the Mexican side, to take advantage of an effective labor rate of about $1.10 per hour; final assembly takes place in the United States, so the product can bear the "Made in USA" label.

> Some geographic areas haven't been able to shake off their lethargy, no matter what type of industry they boast

Sanyo and Ford make up just two of the 800-plus maqui companies, says Beaudette. "The cost of the physical plant is about the same in the United States and Mexico," he says. "But the cost of the facility is relatively insignificant compared with the cost of labor. That's the big ticket."

However, financing also plays a part in companies' expansion decisions, and the political climate hasn't been kind to industrial development. Investment in industrial development bonds slowed to a crawl when it was feared that Congress would kill all bond-related tax exemptions, says Don Backstrom, executive director of the California Industrial Development Financing Advisory Commission in Los Angeles. In its final form, the Tax Reform Act disallowed tax-exempt bonds for commercial, retail and warehouse space, but kept tax-exempt status for manufacturing space. It also imposed a $10 million per project limit on tax exempts.

"Any electronics firm with manufacturing applications can still take advantage of tax-exempt bonds," says Stephen Hamill, chief executive of financial advising firm H.B. Capital Resources Ltd. of Pleasanton, Calif. "The message is: Bonds are alive and well."

However, the state of the economy in California and confusion over the bonds status dampened investor enthusiasm last year, at least in California. "This year has been pretty doggone slow," says Backstrom. However, he says investors are "coming back to the table" now that the tax implications are better understood. Backstrom's agency expects to reach its cap of $350 million next year (up from $250 million). Last year, the agency sold only $150 million worth of bonds.

Yet, as important as financing and quality of life may be, they pale beside the culture and economy that have taken decades to develop in the Silicon Valley. And for that area, the outlook — while not overwhelmingly positive — is slightly rosier than it was last year, which bodes well for the industry as a whole. ▷

Top 15 high-tech employment growth centers

Metro area	1986 employment (thousands)	Total job change 1980-1986 (thousands)	Average annual change 1980-1986 (percentage)
San Jose, Calif.	234	49.8	4.5%
Boston, Mass.	175	36.9	4.4%
Los Angeles, Calif.	297	25.6	1.6%
Dallas, Texas	96	22.5	5.1%
Phoenix, Ariz.	69	17.7	5.8%
Anaheim, Calif.	114	17.3	3.0%
Seattle, Wash.	101	16.7	3.3%
Washington, D.C.	34	14.0	11.6%
Atlanta, Ga.	35	9.8	6.5%
Nassau-Suffolk, N.Y.	85	9.6	2.1%
San Diego, Calif.	64	9.4	2.8%
Philadelphia, Pa.	66	8.9	2.6%
Tampa, Fla.	23	8.4	9.3%
Minneapolis, Minn.	58	8.3	2.8%
Ventura-Santa Barbara, Calif.	30	7.8	5.9%
National total	3,731	457	2.3%

Source: Grubb & Ellis Research Services, U.S. Department of Commerce, Bureau of Labor Statistics

NORTHEAST

Connecticut

Additional information

Name: Mark Feinberg

Agency: Connecticut Department of Economic Development

Address: 210 Washington Street, Hartford, Conn. 06106

Phone: (203) 566-5546

Maine

Additional information

Agency: State Development Agency

Address: 193 State Street, Augusta, Me. 04333

Phone: (207) 289-2656

Massachusetts

Business conditions

Total electronics workforce 120,300

Average hourly wage (production line) $9.72

Average annual salary for electrical engineers . . . . . .$26,700-$40,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 15

Additional information

Name: William J. Sugrue

Agency: S.I.T.E. Program, Department of Commerce and Development

Address: Leverett Saltonstall Building, Government Center, 100 Cambridge Street, Boston, Mass. 02202

Phone: (617) 727-3215

New Hampshire

Business conditions

Total electronics workforce 25,052

Average hourly wage (production line) $10.45

Average hourly wage (clerical) $7.51

Average annual salary for electrical engineers $22,000

Additional information

Name: William G. Herman

Agency: Office of Industrial Development

Address: P.O. Box 856, Concord, N.H. 03301

Phone: (603) 271-2591

New Jersey

Business conditions

Total electronics workforce 180,265

Average hourly wage (production line) $8.00

Average hourly wage (clerical) $5.25

Average annual salary for electrical engineers $35,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 4

Additional information

Name: George Nagle, director

Agency: Office of Economic Research, New Jersey Department of Commerce and Economic Development

Address: One West State Street, Room 509, Trenton, N.J. 08625

Phone: (609) 292-2423

New York

Business conditions

Total electronics workforce 154,300

Average hourly wage (production line) $9.92

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects: EE = 21; computer science and other = 72

Additional information

Name: Raymond G. Paolino

Agency: New York State Department of Economic Development

Address: One Commerce Plaza, Albany, N.Y. 12245

Phone: (518) 474-8670

Pennsylvania

Business conditions

Total electronics workforce 98,100

Average hourly wage (production line) $9.74

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 41

Additional information

Name: Bradford R. Ehrhart

Agency: Pennsylvania Department of Commerce, Bureau of Economic Research and Legislative Analysis

Address: Room 469, Forum Building, Harrisburg, Pa. 17120

Phone: (717) 787-4088

Rhode Island

Business conditions

Total electronics workforce 20,000 (manufacturing)

Average hourly wage (production line) $8.25

Average hourly wage (clerical) $6.00

Average annual salary for electrical engineers $40,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

Additional information

Name: Kenneth Willette

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Address: 7 Jackson Walkway, Providence, R.I. 02903

Phone: (401) 277-2601

Vermont

Business conditions

Total electronics workforce 12,100

Average hourly wage (production line) $6.22

Average hourly wage (clerical) $5.68

Average annual salary for electrical engineers $34,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

Additional information

Name: Fred Newhall

Agency: Vermont Economic Development Department

Address: 109 State Street, Montpelier, Vt. 05465

Phone: (802) 828-3221

ATLANTIC

Delaware

Business conditions

Name: Dale E. Wolf

Agency: Delaware Development Office

Address: 99 Kings Highway, P.O. Box 1401, Dover, Del. 19903

Phone: (302) 736-4271

Florida

Business conditions

Total electronics workforce 76,451

Average hourly wage (production line) $4.35

Average hourly wage (clerical) $4.87

Average annual salary for electrical engineers $24,100

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 8

Name: Steve Mayberry

Agency: Florida Department of Commerce, Division of Economic Development

Address: 501B Collins Building, 101 East Gaines Street, Tallahassee, Fla. 32399-2000

Phone: (904) 488-6300

Georgia

Business conditions

Total electronics workforce 31,922 (manufacturing)

Average hourly wage (production line) $8.34

Average hourly wage (clerical) $6.92

Average annual salary for electrical engineers $41,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

Additional information

Name: Director of Marketing

Agency: Department of Industry and Trade

Address: 230 Peachtree Street, Suite 700, Atlanta, Ga. 30303

Phone: (404) 656-3545, 656-7795

Maryland

Name: Jim Pifer

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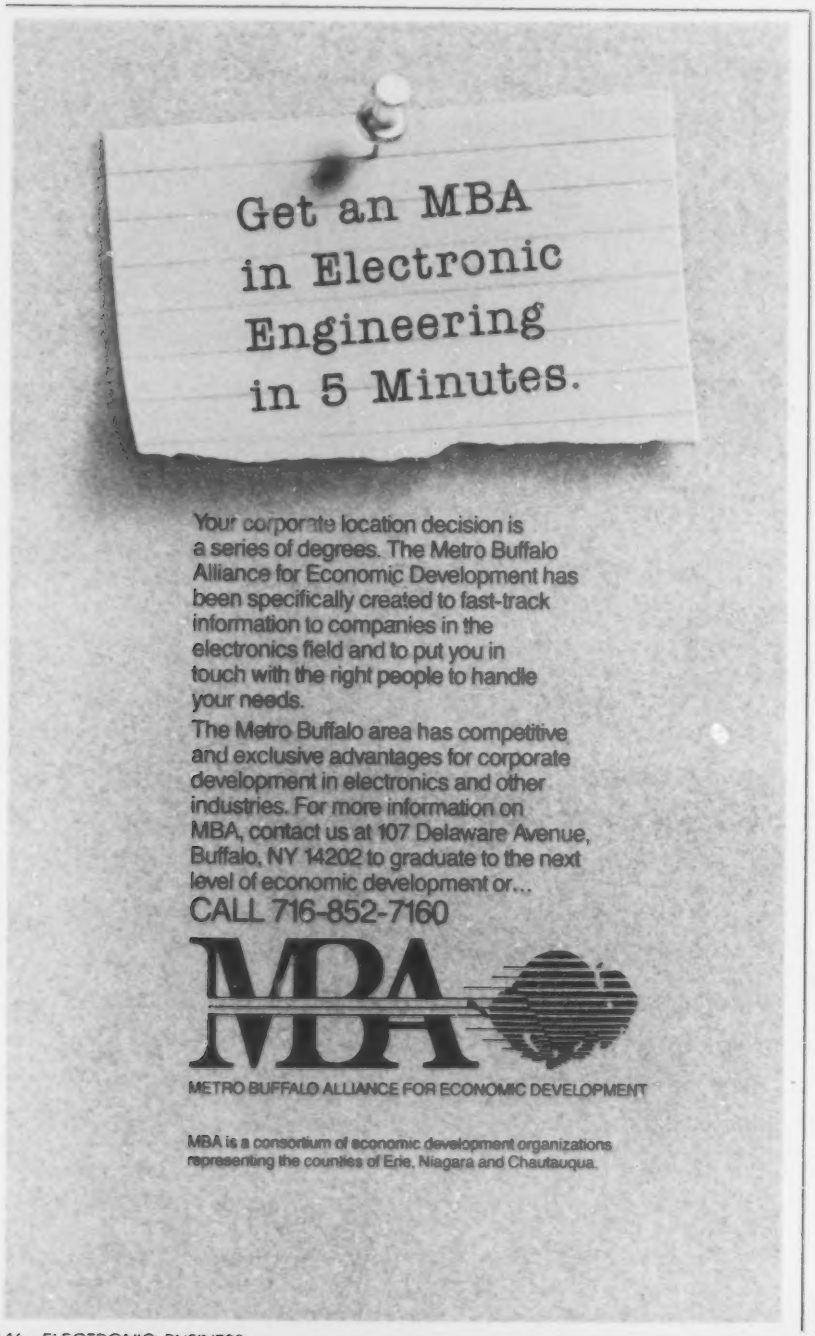
Phone: (301) 269-3566



North Carolina

Business conditions

Total electronics workforce 61,000

Average hourly wage (production line) $8.92

Average hourly wage (clerical) $6.87

Average annual salary for electrical engineers $28,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 5

Additional information

Name: Earle L. Bradley

Agency: North Carolina Department of Commerce

Address: 430 N. Salisbury Street, Raleigh, N.C. 27611

Phone: (919) 733-4094

South Carolina

Business conditions

Total electronics workforce 45,000

Average hourly wage (production line) $8.08

Average hourly wage (clerical) $6.35

Average annual salary for electrical engineers . . . . . .$28,000-$45,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

Additional information

Name: Sena H. Black

Agency: South Carolina State Development Board, Research and Information Resources

Address: 1201 Main Street, Columbia, S.C. 29202

Phone: (803) 737-0400

Virginia

Additional information

Name: Hugh D. Keogh, director

Agency: Virginia Department of Economic Development

Address: 1000 Washington Building, Richmond, Va. 23219

Phone: (804) 786-3791

West Virginia

Business conditions

Total electronics workforce 2,700

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 1

Additional information

Name: Lysander L. Dudley Sr., director
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SOUTH

Alabama

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Arkansas

Additional information
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Phone: (501) 371-1971

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Kentucky

Business conditions
Total electronics workforce 5,000
Average hourly wage (production line) $10.09
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3

Additional information
Name: Ronald Morgan
Agency: Kentucky Commerce Cabinet
Address: 2400 Capital Plaza Tower, Frankfort, Ky. 40601
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Louisiana

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Address: Box 94185, Baton Rouge, La.
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Mississippi

Additional information
Name: Jerry McDonald
Agency: Mississippi Department of Economic Development
Address: 1201 Sillers Building, 500 High Street, Jackson, Miss. 32901
Phone: (601) 354-7011

Oklahoma

Business conditions
Total electronics workforce 14,500
Average hourly wage (production line) $10.42
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3

Additional information
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Agency: Industrial Division, Department of Commerce
Address: 6601 Broadway Extension, Oklahoma City, Okla. 73116-8214
Phone: (405) 843-9770

Tennessee

Additional information
Name: John M. Crothers
Agency: State of Tennessee Department of Economic and Community Development

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Phone: (615) 741-5070

Texas
Additional information
Name: Jack Alexander
Agency: Texas Economic Development Commission
Address: P.O. Box 12728, Capitol Station, Austin, Texas 78711
Phone: (512) 472-5059

MIDWEST

Illinois
Business conditions
Total electronics workforce 123,100
Average hourly wage (production line) $20.57
Average hourly wage (clerical) $9.46
Average annual salary for electrical engineers $34,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 186
Additional information
Name: Bob Henningsen, bureau chief
Agency: National Marketing, Iowa Development of Economic Development
Address: 200 East Grand Avenue, Des Moines, Iowa 50309
Phone: (515) 281-3210

Kansas
Business conditions
Total electronics workforce 9,500
Average hourly wage (production line) $6.40
Average hourly wage (clerical) $6.50
Average annual salary for electrical engineers $27,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 3
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Agency: Manufacturing Services

Indiana
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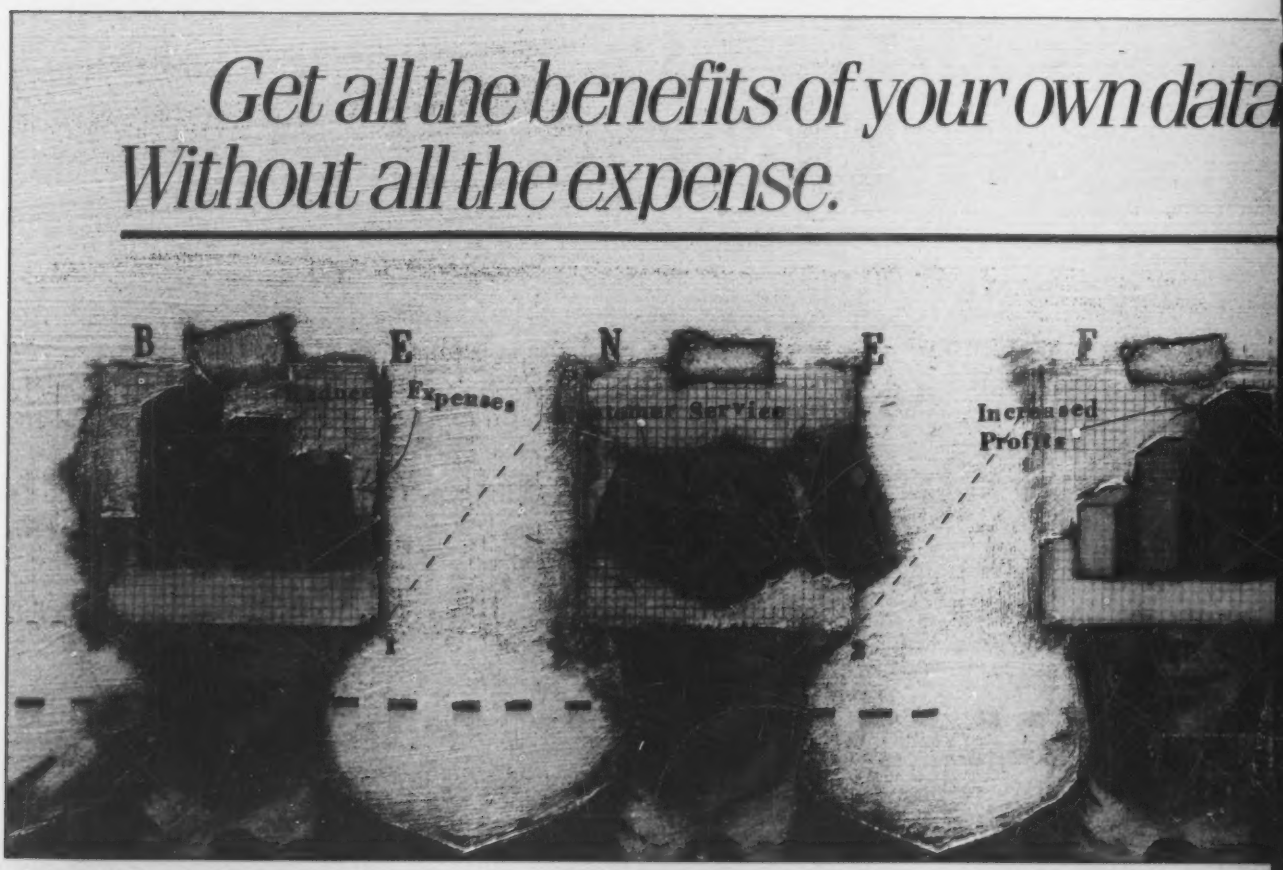
Phone: (317) 232-8888

Iowa
Business conditions
Total electronics workforce 10,850
Average hourly wage (production line) $10.32
Average annual salary for electrical engineers . . . . . .$27,738-$34,736
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 5
Additional information



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Missouri

Business conditions

Total electronics workforce 82,000

Average hourly wage (production line) $9.73

Average hourly wage (clerical) $6.30

Average annual salary for electrical engineers $30,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 52

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Nebraska

Business conditions

Total electronics workforce 8,258

Average hourly wage (production line) $9.28

Average hourly wage (clerical) $4.67

Average annual salary for electrical engineers $50,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 2

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Additional information

Agency: Department of State Development

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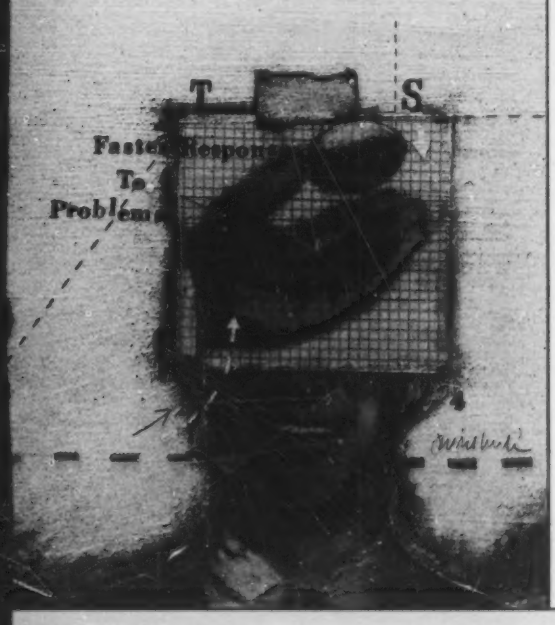

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Business conditions
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 4
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Agency: Planning and Economic Development Department
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Phone: (808) 548-4620

Oregon
Business conditions
Total electronics workforce 44,300
Average hourly wage (production line) $4.34
Average hourly wage (clerical) $4.37
Average annual salary for electrical engineers . . . . . .$27,000 (entry level)
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 15
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Phone: (503) 373-1200

Washington
Business conditions
Total electronics workforce 148,698
Average hourly wage (production line) $7.56
Average hourly wage (clerical) $5.84
Average annual salary for electrical engineers $26,500
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects 12
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VBPA ABP

Record year for semiconductors: A $32 billion world market

Of this larger pie, the U.S. has a smaller share. But U.S. companies did much better than last year

Fade into oblivion, 1984. Step aside, 1986. At only $26 billion, you are no longer the biggest years in world semiconductor market history. That distinction belongs now to 1987. The world will have bought $32 billion worth of chips by the time this year is over, 22% more than in 1986, according to the recent forecast by the Semiconductor Industry Association. Moreover, says the trade association, 1988 will be even better with almost as much growth, 18%.

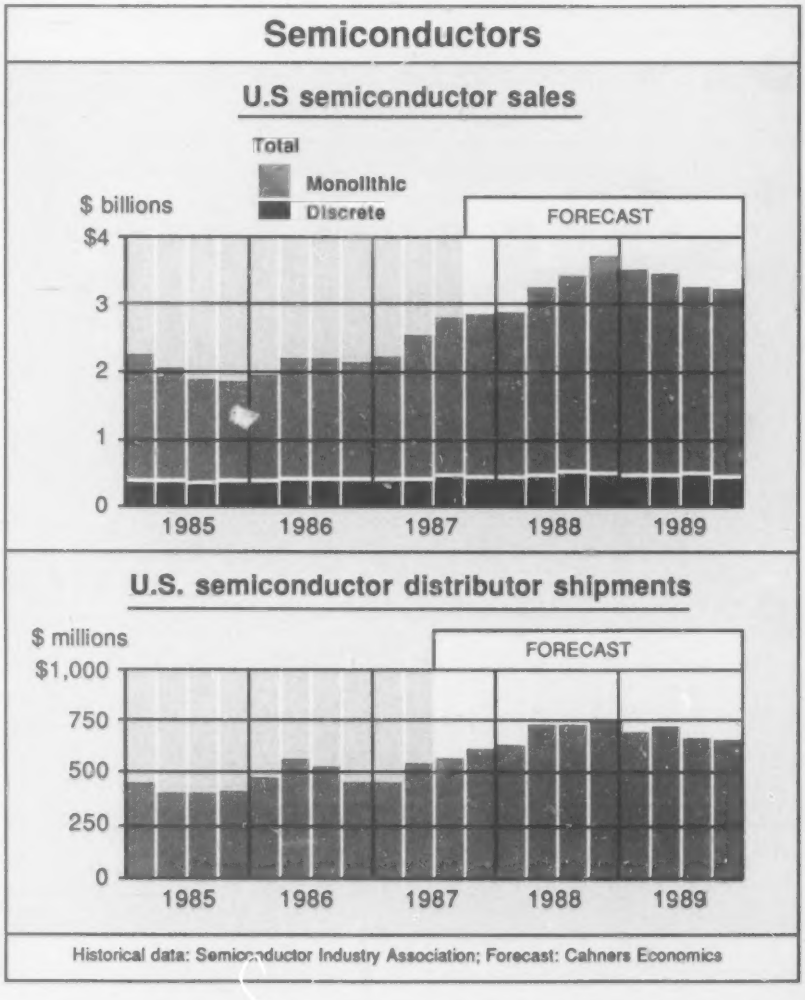
It is not the first time that the SIA's World Semiconductor Trade Statistics group has forecast a rosy future from the vantage point of a good year. Unfortunately, when it did so back in September 1984, it predicted that 1985 would be the year of the $32 billion world market, thus completely missing the recession that shrank the market to only $21.5 billion.

But the SIA is on very firm ground with its 1987 forecast, especially with its prediction of 20% growth for the U.S. market. Domestic manufacturers have moved aggressively to defend their growing turf, as weil as to participate in the worldwide market. Intel Corp.'s revenue proves it has done so successfully. Its sales increased in the third quarter by 55% over last year, after growing 42% in the first half. ASIC specialist LSI Logic saw its revenue increase by 49%, the same percentage as linear specialist (but six times smaller) Linear Technology Corp. Even Advanced Micro Devices Inc., which has been slow to participate in the recovery, advanced 14% in the third quarter, after an increase of 18% for the first half.

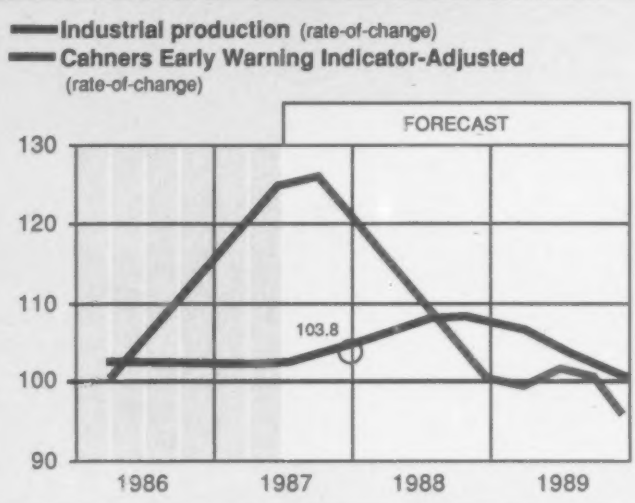
Conservatively, the SIA forecasts another 20% increase for the U.S. market in 1988. Based on the Cahners Early Warning Indicator, economist Elizabeth Baatz forecasts that the U.S. market will gain 22% this year and do even better, 28%, in 1988. Unrelated to Cahners' methodology, but supporting its conclusions, is the fact that the revenue of big users of chips have been increasing substantially. In the third quarter, Digital Equipment Corp. advanced by 24%. Workstation specialist Sun Microsystems Inc. doubled its revenue in the same period. And, on its way to becoming a billion-dollar company, Seagate Technology's sales grew by 20%.

When analyzing the $32 billion world of semiconductors, the sobering fact emerges that the largest share, 38%, is Japan's. This country won leadership through both the internal growth of its electronics consumption and the strengthening of its currency. To free its forecast from the influence of the latter factor, the SIA has forecast Japan's market in yen. It predicts a slow 2% growth for this year, and a healthier 13% for 1988. If so, the U.S. may regain next year some of the ground it lost to Japan.

ALBERTO SOCOLOVSKY



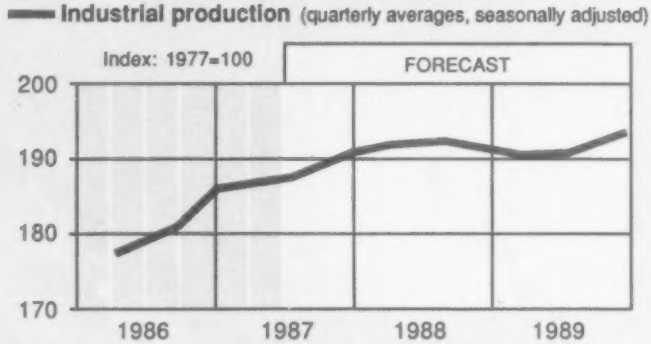
Economic indicators



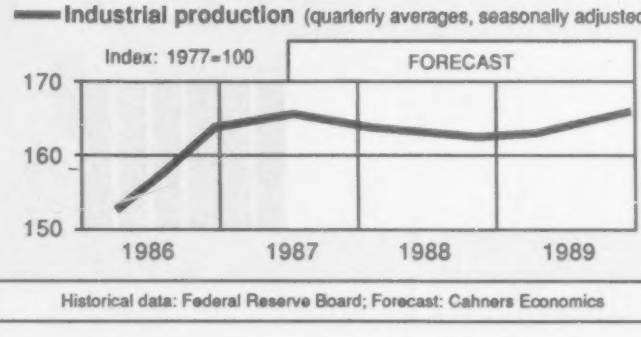
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Industrial production

Defense and space equipment



Aircraft and parts



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. This spring output rose 0.7%, according to estimates from the Federal Reserve Board. This slow and steady growth is expected to continue until next summer. Production is expected to rebound after a year and a half of sluggish growth pushing production up 6.8% in 1988. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar, inventory replenishment and growth in business equipment investment.

The Cahners Early Warning Indicator has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. This leading indicator, (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index, has proven to be an excellent forecasting tool. It forecasts the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.8 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.8% above 1986.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Defense and space production

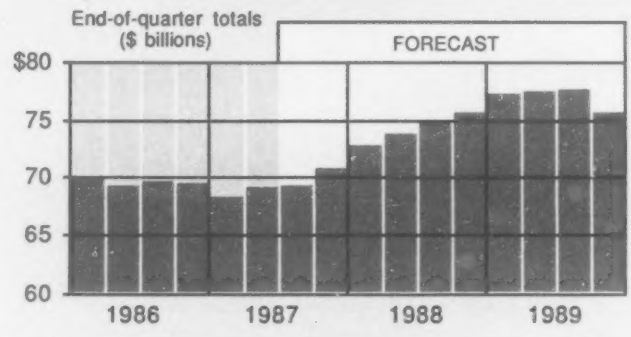
Production of defense and space equipment rose 0.2% in the second quarter and is expected to rise another 0.8% in the third quarter. Stronger gains in the fourth quarter are expected to push annual growth to 4.1%, down 1.2% from last year and 5% below 1985's growth rate. Defense equipment production will slow even further in 1988 and 1989 as federal budget constraints loom.

Aircraft and parts production

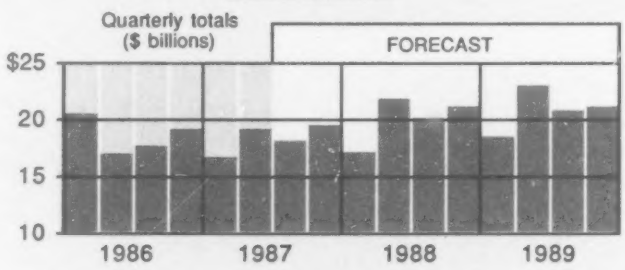
After a 0.5% gain in the second quarter, output of aircraft and parts is expected to fall in the second half of the year. Stronger gains early in 1987 will still push annual gains to 4%. While disappointing after over 10% annual gains in the previous two years, the business cycle points to an even sharper slowdown in 1988. Orders for aircraft were weak in the first half of 1987 as a 27% surge in commercial orders failed to completely offset an 8% drop in defense aircraft orders.

Communication equipment (SIC 366)

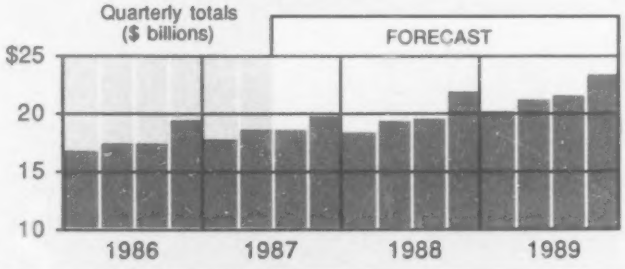
Unfilled orders



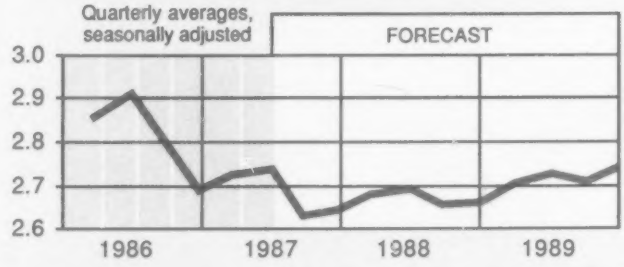
New orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

In the third quarter, new orders for communication equipment rose an estimated 2.8% above a year ago, but fell 5.7% below second quarter orders. Even an expected 1.1% increase in the current quarter will only push communication equipment orders to $72.4 billion for 1987, 1.2% below 1986 and 4.7% below 1985's record orders. Most of the decline in orders so far in 1987 has been due to a weak defense sector. Orders for communication equipment from defense buyers fell 15.4% in the first seven months of 1987. Luckily, commercial markets are rebounding and are expected to offset defense losses next year. Orders from commercial buyers actually jumped 13.7% in the first seven months of 1987. In 1988, all communication equipment orders are expected to rise 9.2%.

Unfilled Orders

Backlogs of communication equipment have remained fairly steady, according to the Census Bureau's tabulation of last summer's data. At $68.2 billion in August, backlogs are down just $200 million from last spring and $600 million from a year earlier. With orders now on the rise, especially in the more competitive, market-driven commercial markets, expect backlogs to inch upward throughout 1988 and into the first half of 1989.

Shipments

Compared with the second quarter of 1987, shipments of communication equipment rose 0.5% in the third quarter of 1987 to top year-ago shipments by 6.9%. Fourth quarter gains were probably a bit more modest, but by the end of 1987 shipments are likely to have hit $73.4 billion, a 5.3% annual gain. Shipments are expected to rise another 5.9% in 1988 and 9.6% in 1989. Any negative years are not likely until 1990 when the business cycle heads back down. But any expected business cycle downturn will be weak in amplitude and short in duration.

Inventory-to-shipment ratio

Paralleling the tightening of inventory in other industries, communication equipment inventory-to-shipment (I/S) ratio fell to 2.62 in August 1987, down from 2.80 in February. Over the February-August time period, inventory rose 2.4% but shipments rose 9.4%, pushing the I/S ratio down. This ratio stood at 2.62 in November 1986 and has been hovering between 2.8 and 2.6 ever since. The last time the I/S ratio stayed in this range was back in early 1983. With rising interest rates and the increasing cost of holding inventory, the I/S ratio for communication equipment should remain relatively low next year.

KOREAN ELECTRONICS

What Korea's elections mean to U.S. electronics firms

First the labor strikes; now, the vote on a new president. U.S. suppliers *and* buyers are on alert

"This will be my first time to vote. Still, I cannot believe it," says a Seoul taxi driver in his early 30s. For more than 16 years, South Koreans have been denied the right to participate in evenhanded elections. But after massive social unrest last spring, President Chun Doo Hwan finally agreed to step down after years of authoritarian rule. Koreans are understandably elated about the upcoming presidential election, just days away.

Across the Pacific, American executives, supplying equipment to and buying products from Korea, are also on the alert. And with good reason. U.S. companies doing business in Korea have pumped more than $1.2 billion into the country, according to the Korean Ministry of Finance. In electronics products alone, North America's trade with Korea — imports plus exports — topped $4.8 billion last year.

Although all four presidential candidates in the upcoming election are violently clashing on a myriad of issues, they all have agreed on one thing: the miraculous progress of Korea's economy, which grew 12.5% in real terms last year, *must* continue. "The economy here is on a roll and no one is going to tamper with that," says Steve P. Tsitouris, managing director of AT&T's Seoul office.

In fact, the economy is a virtual nonissue in the campaign. By American standards, the election in Korea has become more of a personality contest. None of the candidates has outlined any definitive economic plans yet. Still, differences in the backgrounds and ideologies of the four men will probably have an impact on their decisions in labor and trade policies, two crucial areas of concern for U.S. companies doing business with Korea.

Of the four candidates, former Prime Minister Kim Jong Pil is seen as the long shot. He is a conservative backed by Koreans wanting little change. Also of a conservative nature, Roh Tae Woo, President Chun's hand-picked successor, has strong ties with the military and business community. Opposition candidates Kim Young Sam and Kim Dae Jung are viewed as being reformatory and liberal, although by American political calibrations, they are really right-wingers. Kim Young Sam is considered the more moderate of the two.

Opposition candidates Kim Dae Jung, left, and Kim Young Sam. Good for labor but bad for foreign trade?

Until last summer, Korea's economy was humming. The country recorded a $3.1 billion trade surplus last year, its first in modern times. In particular, Korea's electronics industry grew by a mind-boggling 45.6% in 1986, according to the Electronic Industries Association of Korea (EIAK).

Labor woes

Then came the labor strikes. The Korean Labor Ministry now admits that the country suffered more than 3,300 strikes by hundreds of thousands of workers last summer. In sharp contrast, the government recorded just 276 labor disputes in all of 1986. Korea's well-tuned export-driven economy nearly cracked under the pressure. The country's Ministry of Trade and Industry (MTI) reported that although trade surpluses were averaging more than $500 million a month earlier this year, the August figure had nosedived to $94 million.

Although the strikes were concentrated in the automobile and shipbuilding industries, high-tech companies were also affected. At Daewoo Electronics Company Ltd., factories closed for two weeks causing delivery times to double. Goldstar Semiconductor Ltd.'s shutdown lasted 10 days. MTI conceded recently that Korea's electronics exports were $200 million off target last August.

Virtually all of the manufacturing strikes were settled by summer's end and MTI asserts that export and production numbers have since rebounded. But Korea's new president, whoever he may be, must deal with the distinct possibility of further labor problems when wage contracts are renegotiated this spring.

Although average salaries in electronics manufacturing were increased

UPI/Bettmann Newsphotos

UPI/Bettmann Newsphotos

Social unrest and labor strikes upset Korea's economy last summer. The government now admits that it was $200 million off target for August electronics exports

by more than 25% this year, many workers say it was not enough. "Yes, we did get a large raise but our pay was so low to begin with," complains one blue-collar worker whose hours run from 8:30 a.m. to 8 p.m., six days a week, at Goldstar's personal computer factory in Pyongtaek. Indeed, even after the recent salary raises, skilled Korean employees in electronics assembly are averaging just $1.50 an hour, according to the Center for Foreign Investment Services in Seoul.

Management now concedes that mistakes were made. "Korean industry has grown at the expense of our workers," admits Park Kwang Oh, a vice president in charge of semiconductor R&D for Hyundai Electronics Industries Company Ltd. "Some workers feel that they have been sacrificed," acknowledges another Korean company executive.

Bitter resentment

However, many white-collar employees bitterly resent the concessions won by their blue-collar counterparts. Lee Kuen Tae, deputy general manager of the planning department for Daewoo Electronics, complains that a 27-year-old college graduate working for Daewoo now earns less than a manufacturing employee of the same age. "Next time we have any labor disputes," says Lee, "we will have a stronger government to help us."

Indeed, many business executives privately complain about President Chun's lax handling of the labor strikers. Political analysts explain that Chun, who seized power through a military coup in 1980, restrained himself last summer in order to curry favor with Korea's huge bloc of middle-class voters. In the past, when free elections were nonexistent, the government and big business conspired to keep wages low in order to fuel economic growth, allege many Korea watchers.

Not surprisingly, the big business community is rallying behind right-wing candidates Roh Tae Woo and Kim Jong Pil, both perceived as willing to use strong-arm tactics to keep the country in order. And the labor movement favors the opposition candidates. "Kim Dae Jung would probably bring about the democratization of the unions the quickest," says Lee Eun Jin of the Korean Labor Association.

A scheduled collision

Korea's new president will need to act fast. Labor and management are headed for a collision next spring when contracts are scheduled for renegotiation. Labor union insiders say they will be demanding an overall average wage increase of 15% and an even higher increase for workers in the electronics industry. Management and government officials, on the other hand, say they are still recovering from last summer's concessions. "We know that a double-digit wage increase will be expected and that is our problem," says Seo Sa Hyeon, a director of MTI's Electronic Industry Bureau.

To make matters worse, management and labor have little experience in dealing with one another. It is the classic example of two opponents who have made the mistake of underestimating the other's strength. "Management is retrenching and

Electronics assembly workers in Korea still earn about $1.50 an hour even after a more than 25% pay raise

starting to go back on some of its promises," notes George Long, research analyst with investment brokerage W. I. Carr Ltd.'s Seoul office. Such talk does not scare one labor union leader who says, "Every employer is really frightened of us."

The good news for America is that any future labor unrest will probably be contained within only the Korean companies. U.S. firms escaped relatively unscathed last summer because they were generally paying higher wages and providing better working conditions in Korea than the indigenous companies were. Molex Inc., a Lisle, Illinois-based manufacturer of connectors, experienced a 4-hour strike in its Ansan factory. Tandy Corp. reported "minor" problems in its two Korean plants where the company makes cellular phones and electronic components. Bigger losers were those U.S. companies involved in a Korean joint venture. AT&T owns 44% of Goldstar Semiconductor, victim of a 10-day shutdown.

Further labor problems could lead to trouble for the hundreds of U.S. companies depending on Korean parts or products. Last year, North America imported $3[illegible] billion worth of Korean electronics goods, according to the EIAK. IBM alone will buy around $180 million this year, according to John Bishop, president of IBM Korea Inc.

But because of the current political and economic uncertainties in Korea, many U.S. customers have become wary. "Being totally dependent on Korea at this point is suicidal," asserts Jerry Wasserman, a vice president for Arthur D. Little Inc., a Cambridge, Mass., consulting firm. Still, some U.S. companies remain solesourced on Korean suppliers. Vodavi Technology Corp., a telecommunications company in Scottsdale, Ariz., depends totally on Goldstar for manufacturing. After saying he is "broadly concerned" about the situation in Korea, chief executive Stanley Blau adds, "we are currently discussing with Goldstar the possibility of them manufacturing our products outside of Korea." No decision has been made yet.

President Chun will soon step down. Under his strict rule, Korea's electronics industry grew 45.6% last year

Leading Edge Hardware Products Inc. of Canton, Mass., may also be courting trouble. The company buys all of its Model D personal computers, of which it has sold 350,000 units so far, from Daewoo. "Last summer we didn't experience any glitches in supply but there's no question that we were concerned," says John Sullivan, marketing vice president. "We're watching the situation now with guarded optimism."

Simmering trade friction

Labor problems will not be the sole concern of Korea's new president. Simmering trade friction also threatens to upset the country's economic apple cart. Many a U.S. politician has pointed an accusing finger at the flood of Hyundai cars, Samsung televisions and Goldstar VCRs pouring into the American marketplace. The United States' $7.4 billion trade deficit with Korea in 1986 and Wall Street's crash last October, which many analysts feel was touched off by disappointing U.S. August trade deficit figures, have only intensified calls for retaliatory measures.

"Korea now realizes that it's a give-and-take situation and we will open our markets more and more," asserts Park Baeng Moon, a general manager of the corporate planning office for Samsung Electronics Company Ltd. Indeed, via a goodwill visit to the United States last summer, Korean electronics executives purchased more than $300 million worth of products from U.S. concerns.

Furthermore, the Korean government, under the leadership of President Chun and his deputy Roh Tae Woo, has removed many market restrictions and lessened various import tariffs. Foreign personal computers are now being allowed into the country and tariffs on electronics products have been slashed by one-third, according to the EIAK. Nonetheless, foreign executives say the Korean government still has quite a ways to go. "A Ford Taurus should not cost $57,000 in Seoul," complains one U.S. expatriat.

But whether Korea's new president will continue pushing market doors open is unknown. Ironically, both op-

position candidates Kim Dae Jung and Kim Young Sam have actually been more conservative and nationalistic in their foreign trade views than their opponents. Both Kims have blasted the current government by saying that acquiescing to U.S. interests will lead to higher Korean unemployment.

Some political analysts say the United States should not be concerned because the Kims' accusations are nothing more than campaign rhetoric that serves two purposes: provides the Kims with something to complain about and allows them to win favor with Korea's workforce and unions. Nonetheless, U.S. business executives should be concerned if one of the two Kims does win. Critics say neither Kim Dae Jung nor Kim Young Sam has the political diplomacy or foreign relations expertise necessary to balance Korean jobs against U.S. calls for market liberalization.

Philippines-like chaos

For the time being, the primary concern for U.S. businesses is that the elections are held without disruption. Any attempt to rig them might send the country spiraling into Philippines-like chaos. Although Koreans bristle when they hear the comparison, Korea's tortuous history suggests that the analogy is not totally unwarranted.

Since being established in 1948, South Korea has yet to see a peaceful transfer of leadership. President Chun seized power after the previous president was assassinated by his own secret intelligence director. Korea is a country where military coups and martial law are well known. "I smelled tear gas there for the first time," says one American businessman who is now back in the United States. Some posh hotels in Seoul now provide their guests with gas masks.

Further labor problems could lead to trouble for hundreds of U.S. companies depending on Korean parts or products

Still, Carter Eckert, professor of Korean studies at Harvard University, says, "It'll be very difficult for the government to control the election at this point because the whole world will be watching.... If the election is contrived, it'll be fairly obvious and there's going to be an outrage." Eckert, who is currently in Seoul on a task force to help deter election fraud, adds, "The elections are going to have to be fair. But I'm going to have to find some wood to knock on."

Some foreign firms are jittery. "We've made alternate arrangements for getting material into and out of Korea," says Sandy D'Arcy, managing director of international sales and marketing for VLSI Technology Inc. of San Jose.

Rumor has it that Japan's Sanyo Electric Company Ltd. will relocate its three Korean plants to Malaysia. Sanyo would neither confirm nor deny the rumor but a spokesman says that if the company were to move, it would be because of Korea's rapidly rising labor costs and not due to any uncertainty over the country's political situation. He would not comment further.

Mum is also the word at Wang Laboratories Inc., headquartered in Lowell, Mass. When asked whether Wang was concerned about Korea's current economic and political environment, Chauncey C. Chu, manufacturing vice president, replied with the utmost diplomacy: "We made the decision to manufacture in Korea two years ago. If we were making the decision today, we probably may or may not have come to the same conclusion."

Other Americans are pooh-poohing the situation. Referring to the massive labor strikes last summer, Arthur W. Zafiropoulo, president of Drytek, a General Signal Corp. subsidiary, says, "We had the same thing here in the U.S. during the '60s." Adds James A. Hill, president of ECAD Inc., headquartered in Santa Clara, Calif.: "I think we're just seeing a short-term perturbation there." Consequently, Hill says ECAD will be investing more than $200,000 in Korea next year.

George B. Cobbe, president of Samsung Hewlett-Packard, is similarly nonchalant. When asked whether he was ever afraid for his family's personal safety in Korea, he replied, "Hell no." Then, pointing at the street below his 14th-floor Seoul office, he added, "It's more dangerous down there because of the way those crazy taxi drivers drive." Last summer, those cabbies were on strike; they refused to pick up any passengers. In a few days, they will be voting for their new president.

ALDEN M. HAYASHI

Editor's note: An exchange rate of 800 won = $1 was used in calculating dollar figures. Korea's presidential election is scheduled to be held before Dec. 20.

How some U.S. electronics companies have fared in Korea

	Sales ($ milions)		Date	
	1986	1985	founded	Employees
IBM Korea Inc.	$244	$202	1967	960
Motorola Korea Ltd.	239	204	1967	4,500
Goldstar Semiconductor (owned 44% by AT&T)	215	179	1976	3,000
Fairchild Semiconductor Korea Ltd.	56	36	1966	700
Korea Xerox Co.	52	39	1974	1,321
Goldstar Honeywell Co.	16	9	1984	236
Samsung Hewlett-Packard	16	10	1984	286

Source: *B. K. Electronics* magazine

CAE/CAD

Whatever happened to the silicon compilers?

They used to say that silicon compilation would make every engineer a chip designer. It still might happen

Whatever did happen to silicon compilers? They were the "expert" software systems that would allow engineers with no silicon background to design chips. Three years ago, market watchers were predicting that compilation would dominate custom chip design by 1990. All computer-aided design/engineering companies would have to offer compilers, or become also-rans.

It hasn't quite happened that way. The original "Little Three" vendors of silicon compilation — Silicon Compilers Inc., Seattle Silicon Technology Inc. and Silicon Design Labs — failed to meet venture capitalists' hopes that they would emulate the hypergrowth of the "Little Three" of CAE — Daisy Systems Corp., Mentor Graphics Corp. and Valid Logic Systems Inc. And the market remains small. San Jose-based market research firm Prime Data Inc. tabs compiler sales at $48 million this year, and estimates they should reach $180 million by 1991.

In theory, silicon compilers make chip experts out of systems designers. The engineer sets the architectural or behavioral characteristics of the circuit using functional blocks. These blocks may be as simple as multipliers or chunks of memory but could also be entire microprocessors. The software then "compiles" the blocks, automatically laying them out physically and routing data pathways.

The original silicon compiler vendors are much different companies than they were three years ago. Silicon Compilers merged in March with Silicon Design Labs to form Silicon Compiler Systems Corp., which San Jose market research firm Dataquest Inc. says now owns the market. Seattle Silicon dropped the "Technology Inc." for "Corp.," tossed its founder, and now hopes to act equally as a design broker — designing chips and buying time on vacant fabs — and a seller of software. Other candidates for the compiler throne had included Lattice Logic Ltd., bought by chip maker European Silicon Structures, and MetaLogic Inc., now defunct, according to analysts. So the question is not what happened to silicon compilers, but what happened to the silicon compiler companies.

Spreading the gospel

Explains Sam Brown, chief operating officer for Seattle Silicon of Bellevue, Wash.: "There was confusion between a market and a technology. . . . Lots of people are using the technology, but the technology isn't a business. . . . In all honesty, there is a lot of hype with start-ups."

Phillip Kaufman, chairman and chief executive of Silicon Compiler Systems of San Jose: "With the exception of MetaLogic, which was way out on the fringe, everybody is still here. . . . The industry has been forecast to grow very fast and it has grown very fast. The big thing that happened was that the larger companies that were talking compilers — GE, Calma, Mentor — well, if they're still doing it, they've totally internalized it. On the other hand, VLSI Technology and LSI Logic have totally embraced the technology. There has been some backlash. Silicon compilation got a lot of press and there was a lot of hype."

Indeed, the two biggest U.S. custom chip houses, LSI Logic Corp. and VLSI Technology Inc., do use compilation. VLSI Technology's director of design technology, James Rowson, claims he was compiling long before Silicon Compilers offered its first commercial product in late 1984. "Compilers are a natural thing for an ASIC company to do," Rowson says, referring to application-specific ICs, a euphemism for custom chips. So natural, in fact, that VLSI, which used to serve as a foundry for Silicon Compilers, now deems that arrangement too competitive.

"Our mask designers now are only building compilers," Rowson continues. "The object is to do the minimum amount of custom layout possible." He concludes: "Absolutely, the future is going to be full of compilers. As a business, I'm not sure of it, but as a technology, it's right on."

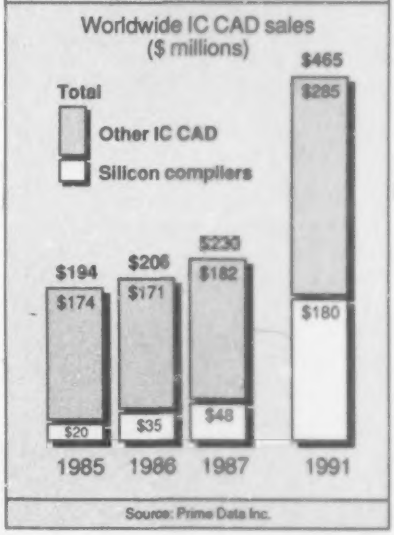
General Electric Co.'s CAD subsidiary, Calma Co., did have a compiler project underway, Gary Leive, Calma's director of IC system development, confirms that "Socrates," its compiler, originally came out of GE Semiconductor's R&D, before Calma moved in. But when Calma consolidated its operations, the North Carolina project spun off on its own. Leive says GE still has some corporate research going on. He declines to say how much GE and Calma invested.

Silicon compilation "has proven to be a difficult problem for a variety of companies that focused on that completely," Leive says. "It has been disappointing to the people who hoped to eliminate custom design."

Tight-lipped

Seattle Silicon and Silicon Compiler Systems are both private, and both tight-lipped about their finances. Seattle Silicon claims to be profitable, but the only thing chief operating officer Brown will say about sales is that he recently booked $700,000 worth of orders in one month. Dataquest says SCS is near profitability, but the two have soaked

Silicon compilers are the fastest-growing IC CAD segment



Source: Prime Data Inc.

up nearly $50 million in venture capital between them.

Seattle Silicon just closed a $3.85 million round of financing and is looking for more. It has a $7 million R&D partnership with a Prudential-Bache Securities Inc. division, not to mention a $7.5 million "strategic partnership" with General Motors Corp. Last fall, Hambrecht & Quist Venture Partners's Stewart Carrell resigned a spot on VLSI Technology's board to run the company. He's looking for a full-time president.

Brown says the company has "changed strategy pretty dramatically" in emphasizing design brokerage as much as it does. He figures to latch on to medium sized runs — 5,000 to 10,000 chips a year — and leave the heavy stuff to the merchant semiconductor companies. He has support deals with National Semiconductor Corp., NCR Corp., Ricoh and United Technologies Microelectronics Center Inc. "Almost any semiconductor company will sell foundry service — it's like the last 10 seats on an airplane," Brown says.

It was either that or be a tools-only vendor. Brown says that SCS is "becoming more of a CAE company. The path they've set for themselves will put them in competition with Mentor and Valid."

Daisy's director of ASIC marketing, Robert Dahlberg, doesn't see SCS as a competitor. "They realize the need to coexist in design environments and are not going to try to displace Daisy or Mentor," he says. Daisy used to resell systems from Silicon Compilers. "We sold a few. It was not a wildly barn-burning success," Dahlberg admits. "Maybe people were buying it so they could say, 'Hey, we've got a silicon compiler — we're on the leading edge.' " But the agreement collapsed after Daisy dropped the proprietary workstation the system was running on.

Neither does Mentor feel heat from SCS, according to Frederick Cohen, director of marketing for IC layout tools. Mentor at one time or another had marketing ties to each of the compilation Little Three. Cohen says Mentor also put together a business plan to look at making a compiler of its own, but opted not to. "I don't think the silicon compilation market is stable yet," Cohen cautions. "I'm not convinced that a year from now we won't see further changes."

DAVID CARD

OPTICAL INSPECTION

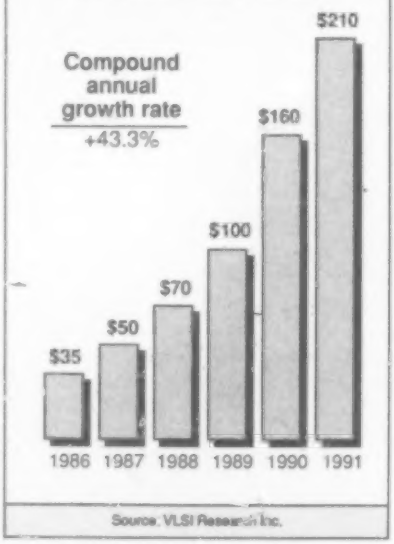
Close inspections of the semiconductor kind

KLA remains the "sun king" of automated semiconductor wafer inspection, but newcomers want to turn out the light

Once upon a time, in the realm of automated wafer inspection, KLA Instruments Corp. was king. For two years, this builder of peopleless systems for inspecting semiconductor wafers ruled the perfect niche — one with little opposition. But, like many a monarchy, this one is being challenged. There are a number of knavish newcomers afoot, releasing or about to release new machines that promise to be faster, smarter or better than the king's. Today, the contenders are milling about Silicon Valley preparing for the battle that will certainly ensue.

All are hungry for the spoils. The market for image-processing systems used in wafer inspection is currently worth about $35 million worldwide, according to VLSI Research, a market research firm based in San Jose. These systems inspect silicon wafers during various stages of fabrication. Some look for process defects. Some perform the task of critical dimension measurement. And others, like KLA's equipment, do both.

In wafer inspection, image-processing systems are hot



Undisputed monarch of this market is KLA, whose first automated wafer inspection product, the 2020 model, hit the streets in early 1985. Since then, the Santa Clara, California-based equipment vendor, "has just walked away with the market [. . . capturing] about 90% of the total," says G. Daniel Hutcheson, director of VLSI Research.

And, Hutcheson believes, KLA "seems poised to capture" even more of this market — which is forecast to grow at an average annual growth rate of 43% through 1991. Indeed, KLA's head start advantage is increasing. Several months ago, the company announced second-generation wafer inspection systems that promise to be four to 15 times faster than its 2020 model and which are scheduled to hit the streets during mid-1988. The company is also beginning to enjoy follow-on orders, a sure indication that market acceptance of its products is gaining. So how can the newcomers — the smaller and/or less entrenched companies — compete?

The answer is: by picking a niche or a different focus, or by making a machine that is faster or cheaper. Those nipping at KLA's heels include vendors such as Cambridge Instruments Inc., E. Leitz Inc., Siscan Systems and Britain's Vickers Instruments as well as the Instrument Group of Japan's Nikon Inc. Although these vendors do not go head-to-head with KLA — their equipment requires operators, does not perform all of the functions of the 2020 family, and can cost approximately $100,000 to $500,000 — their machines are used for wafer inspection. Another supplier, Lasertec USA Inc. of Japan, formerly NJS, has shipped 15 to 20 systems compared with

KLA's installed base of about 50 machines. However, none of the Lasertec units is installed in the United States, and according to VLSI Research's Hutcheson, they pose little threat to KLA.

There are, however, contenders that promise to attack head-on. Their equipment will be price-competitive and, although it may not perform all of the functions of KLA's 2020 family, it is expected to spur some interesting maneuvers over the next several years.

Daring to be different

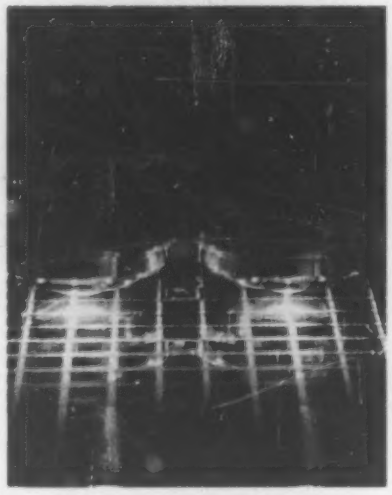
"The real sleeper could be Insystems," says Hutcheson of VLSI Research. San Jose-based Insystems points out that while the competition's equipment must inspect the good with the bad when looking at a wafer — which takes a lot of processing power and precious time — the Insystem machine shows up only the defects. "We decided to do things differently, and not follow the rest of the pack," says George Canavan, Insystems' vice president for marketing. While this approach gives Insystems a speed advantage, the technology limits its use to wafers with highly repetitive patterns, such as on memory chips.

Another contender, Optical Specialties Inc. (OSI), in Fremont, Calif., already has a well-established presence in the market for semiautomatic wafer inspection tools, which automate the wafer handling but require operators with high-powered microscopes to perform the actual inspection. In addition to being price-competitive with KLA — hoping to keep its product under $1 million — the company also hopes to beat the giant in terms of accuracy, according to John Dralla, product marketing manager. However, OSI's product is far from coming out the door. The current schedule calls for beta-site testing at the end of this year, and shipping by mid-1988.

Although there are advantages to coming out after the pioneer, there are also some pitfalls. KLA has "developed the market and brought the customer up the learning curve," says Dralla. But now that customers are coming up to speed, there are worries that the window of opportunity might narrow before OSI begins shipping. "We could be affected by a late entry. It's a concern of ours," notes Dralla, who estimates that his company will sink about $8 million into this product before shipping.

Not to worry. According to Stephen Balog, an analyst with Prudential-Bache Securities Inc. in New York City, that window will be open for some time. The market will eventually be "huge" he exclaims, with enough room for anybody that can make a machine that works. On the downside, however, Balog also predicts that "there'll be more failures than successes." In fact, several automated wafer inspection start-ups have already foundered.

Despite this bleak picture, KLA's challengers believe there is great reason to forge ahead. Advancements in semiconductor technology — line widths that are rapidly shrinking to submicron levels, wafers that can contain 20 or more layers of processes, and wafer diameters that are getting larger all the time — are pushing the need for machines to perform tasks that are exceeding the limitations of the human eye. Consequently, there's a growing need for test equipment that is "faster, smarter and can look at smaller things," points out Peggy Wood, research analyst at Dataquest Inc., a market research firm in San Jose.



KLA's reticle and photomask inspection system can detect quarter-micron flaws

Expensive exotica

But such exotic machines are not cheap. With price tags in the million-dollar range, purchases are limited to buyers with deep pockets. They are also restricted to use only on the leading edge of production lines. While human inspectors can discriminate down to about 30 defects per square centimeter, according to Patrick Lamey, vice president for marketing at KLA's wafer inspection division, the customers buying his kind of equipment are those looking for detection of flaws at one-hundredth of that density.

Indeed, "the people in the bunny suits have to go," says Balog, referring to the operators that use high-powered microscopes to perform critical dimension and process defect testing. While manual systems might be adequate for mature product lines — such as chips with 2-micron line widths or 64Kb DRAMs — they are not up to the task of inspecting extremely dense submicron logic chips or 4Mb DRAMs.

For now, however, semiconductor manufacturers are limiting their use of the million-dollar machines while continuing to invest in the lower priced equipment which offers increasing automation of wafer handling, but is still operator-dependent. For example, chip manufacturer VLSI Technology Inc. is currently spending heavily on capital equipment while retrofitting the fab facility at its San Jose headquarters. This company is also building a new fab with a Class 1 clean room in San Antonio, Texas.

Describing the utilization of the mid- to high-end products, Perry Denning, operations manager at the San Antonio facility, uses a motoring analogy: "You can sit in heavy traffic in a Ferrari, or you can sit in a Chevy and still get to the same place at the same time." The relative lack of speed, as well as the cost of purchasing and then the support of the "Ferraris" makes them "prohibitive to use in an in-line fashion," says Denning.

Instead of placing their KLA inspection machines in "traffic," VLSI has purchased them (one each for its San Jose and San Antonio fabs) for use as engineering tools — for yield enhancement and to pinpoint defects and problems that are a part of the process flow, says Denning. Meanwhile, the "Chevys," or semiautomated equipment, sit in the traffic flow of the wafer fab. Despite the limitations of the "Ferraris," Denning says that the payback, due to yield increases, is less than 18 months, and in some instances can be a lot shorter than that.

CAROL SUBY

SEMICONDUCTORS

1Mb DRAMs: Users scramble to get them

They're new, they're hot, and they're in short supply already. The memory chips are giving both users *and* vendors grief

Start with a popular memory-chip product. Add production problems, international trade disputes, patent infringements and politicians, and the result is chaos. Add a voracious user community waiting to gobble up everything produced and suddenly supply and demand are way out of balance.

There is a worldwide shortage of 1Mb DRAMs in the market today, and most analysts agree it could continue until the end of next year. This shortage, despite its severity, has done at least one good thing: it has reminded large vendors that there is money to be made in commodity memories.

But being a buyer in a seller's market is not very pleasant, and users today are finding vendors sold out of 1Mb dynamic RAMs through the first, second, and even third quarter of next year. And the prices are high.

According to Dataquest Inc., the DRAMs to peak by 1990 at 750 million units and to drop off after that. However, the current shortage may drag that time frame out some, says ICE's market research manager William J. McLean. For comparison, 4 million 4Mb chips will be produced in 1989, jumping to 300 million by 1991.

Supplying the bulk of that demand are five major companies, four of which are Japanese. The Japanese companies, Hitachi Ltd., Mitsubishi difference between supply and demand is wide and getting wider. Production of 1-megabit chips worldwide is expected to be around 50 million pieces by the end of the year, while demand will be closer to 60 million, the San Jose-based market research firm reports.

Another chip market watcher, Integrated Circuit Engineering (ICE) of Scottsdale, Ariz., expects 1Mb Electric Corp., NEC Corp. and Toshiba Corp. will have a 77% share of the market by the end of 1987, according to ICE. Texas Instruments Inc., the only major U.S. supplier, is predicted to have a 10% share of the market by the end of this year. Micron Technology Inc. is the only other U.S. maker of the big memory chips.

Yet all of these companies are unable to keep up with the burgeoning demand for 1Mb chips. Computer, consumer and telecommunications applications are leading the charge for 1Mb chips, and demand is also being fed by the fast, new 32-bit microprocessors such as Intel Corp.'s 80386.

Users, who want to take advantage of the market upturn, are trying to design in more memory and features into new products. Hewlett-Packard Co., which is using 1Mb chips in its reduced instruction set computing (RISC) Spectrum computers, says it has suffered from the shortages. "We continue to be subjected to shortages of 1Mb products and we see no end in sight for the next three to six months," an HP spokesman says.

Unhappy chip makers

Even the chip manufacturers aren't very happy about that. "I would much rather be selling product than controlling my order entry and putting customers on allocation. There is no [1Mb] availability for anyone

Europe's megabit maelstrom

Sales of one-megabit chips are booming in Europe as computer and telecommunications manufacturers bid for limited supplies. Siemens AG and NEC Corp. are the only firms with full-fledged fabs at present. But Hitachi Ltd. and Toshiba Corp. are testing and assembling devices they are shipping from Japan. And some time next year, N.V. Philips GL is likely to begin manufacture, at Nijmegen, Netherlands, of its own 1Mb static random access memory (SRAM) chip.

Megabit chips are clearly a good business to be in right now in Europe. Although the price dropped from $24 at the start of the year to $15 in August, it rose to $18 in September. The demand is also affecting the pricing of 256-kilobit memory chips, which cost $1.70 in January and now go for $3.

Jim Beveridge, director of the European Semiconductor Service of market research firm Dataquest Inc., says: "The European success of the 1Mb chip is closely linked to the recent takeoff of surface mount technology for semiconductors. For the past five years, industry specialists had been claiming that SMT was just around the corner. It was like crying 'wolf' — because those claims never materialized. Now that surface mount has really happened, Europe's semiconductor industry is not ready to cope."

Prudence dictated the strategy that has left the European manufacturers unprepared for surface mount. Reluctant to risk heavy investment in the new technology, they produced designs and handed them over to subcontractors to produce. "Now the subcontractors are inundated," says Beveridge.

Siemens, using technology obtained from Toshiba, began producing its 1Mb DRAMs at a plant in Regensburg, Bavaria, earlier this year and expects to build up to volume levels by Christmas. NEC also prototyped its chip at the beginning of 1987 at a facility in Livingston, Scotland. It is now manufacturing in volume.

Hitachi, whose 1Mb chip test and assembly plant is at Braunschweig, Germany, and Toshiba, which tests and assembles at Landshut, Germany, are likely to build full-scale fabs to meet the demand.

JACK GEE

in the fourth quarter. We are not accepting any new orders for delivery now until the third quarter of 1988," says Robert Merritt, Hitachi America Corp.'s memory marketing manager.

Other users, like Wyse Technology's PC marketing manager Christopher Kryzan, say there is a 50% to 80% price premium for using 1Mb chips compared with the price that four 256-kilobit chips, offering the same amount of memory, would command. "We want to wait until the price is closer to break-even," Kryzan says.

Waiting is something that vendors want users to avoid, since the severe 1Mb shortage could make users decide to hold off until 4Mb chips are available late next year. In the meantime, some vendors believe that these buyers will continue to use 256K chips. That could leave 1Mb chip vendors out in the cold as they ramp up to find that demand has gone elsewhere.

> The severe 1Mb DRAM shortage could make users decide to hold off until 4Mb chips are available late next year

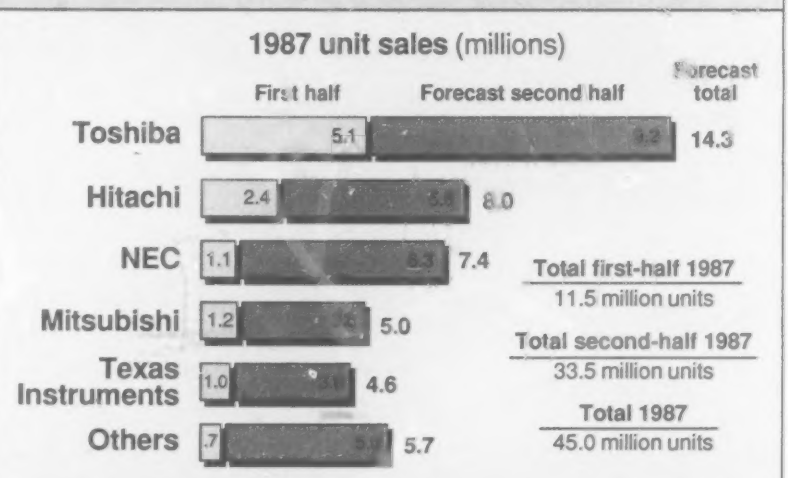
Unfortunately for users, 1Mb DRAMs will continue to be elusive commodities well into next year. If this were a clear-cut case of free market supply versus demand, the length of the shortage might be easier to forecast. As it is, an intricate fabric of politics, international trade issues, and technological challenges is lurking under the guise of a DRAM shortage. The most popular scapegoat, without a doubt, is the U.S.-Japan trade agreement, which calls for production limits on DRAMs shipped into the United States.

"We stepped on our own faces," declares Jack Beedle, president of Scottsdale, Ariz., market researcher In-Stat Inc. "The 1Mb market is whatever Japan's Ministry of Industry, Trade and Information says it is going to be. We all cried that we couldn't compete, and then there were the embargoes. The Japanese are storing parts in warehouses, and prices go up and demand goes up. This is hurting American buyers. In the long run this has benefited the Japanese."

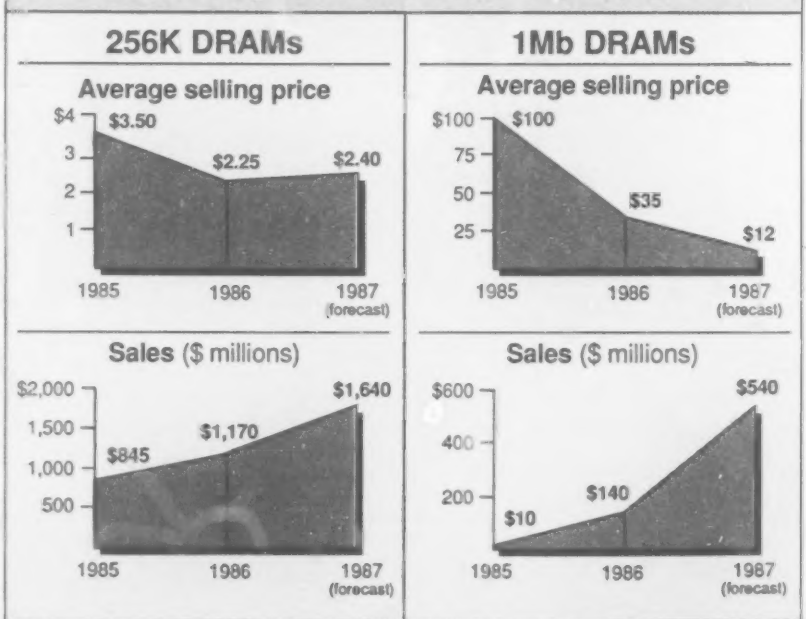
Yet most Japanese manufacturers say that the shortages are caused not by MITI, but by problems in yield that have slowed the ramp-up process. Hitachi's Merritt says that the quotas will not have an impact on his company, insisting that it is more a matter of yield and ramp-up than MITI guidelines.

But ICE market watcher McLean feels that the MITI interference has dragged out the peak times — the length of time between a product's introduction and its peak sales levels — for DRAMs, which had dropped to two years during the period of

Rapid ramp-up: Top 1Mb DRAM makers are racing to keep up with demand...



...and prices for both 256K and 1Mb DRAMs fall fast as dollar volume builds



Source: Integrated Circuit Engineering Corp.

changeover from 16K chips to 64K chips. Once MITI entered the market, three years became the standard peak time for products once again.

"The market is way out of whack," says McLean. "There could have been two times as many units in production this year if MITI had not gotten involved. MITI has gained power in this situation. The Japanese believe they have leverage over the trade agreement. But what are you going to do? If you let production go you get the gray market again."

Upset Japanese

But most Japanese companies seem equally upset at the MITI involvement. Toshiba Semiconductor Corp., which single-handedly accounts for 32% of the 1Mb market, entered into discussions with MITI, trying to raise the ceiling on 1Mb production. Toshiba is currently the only company which has reached the ceiling, according to vice president and general manager Robert Brown.

MITI raised the 1Mb export-quota ceiling for all of Japan's chip exporters from 6.9 million units for the third quarter of 1987 to 14.0 million for the fourth quarter. But, says Toshiba's Brown, "that really doesn't make things any easier. We can now build up capacity more, but we won't be able to take advantage of that until next year. I don't think our fourth-quarter allocation numbers will be met."

Most Japanese chip makers say the shortages are caused not by MITI, but by problems in yield that have slowed the ramp-up process

Many analysts fret that politics may play an even more worrisome role in tightening supply lines. Because of Toshiba's sales of milling machines to the Soviet Union, some members of the U.S. Congress are agitating to ban Toshiba from selling any products in the United States. If Toshiba were to go away, not only would Motorola Inc. lose its 1Mb supplier, but U.S. buyers would lose access to almost 32% of total production.

The political situation may also affect how quickly companies come to market with product, which is another facet of the shortage. One-megabit chips have been slower to ramp up than their predecessors, and one explanation bandied about today is that the Japanese have been discouraged from entering another controlled U.S. market. "Would you put your best people on product development in an area that is going to be restricted in production and in free market pricing?" one industry player asks, noting, "it hasn't been a top priority for us."

Others in the industry say that the fair market value pricing (FMV) structure, which rewards the largest manufacturers — in this case, Toshiba — provided inadequate incentives for other Japanese companies to play in the market because Toshiba had such a large lead. Now that it would behoove these companies to ramp up, they are too far behind, and will take some time to get up to speed.

An artificial shortage

The 1Mb shortage isn't helped by the current shortage of 256K chips, either. According to Dataquest analyst Victor DeDios, there is an artificially created shortage of 256K chips, which is particularly acute for those with special packaging or high-speed requirements. Says DeDios: "What's really causing this shortage is production controls of these chips created by the trade agreement." Compounding the abbreviated production is the greatly increased demand for these chips.

Several Japanese companies, including NEC and Hitachi, are booked on 256K semiconductors through the first quarter of next year. They anticipate continued shortages of chips as users, unable to get the larger 1Mb chips, reach for the 256K units. In fact, DeDios is forecasting that 256K chips are going to stay strong through 1988, contradicting previous beliefs that the 1Mb chips would supplant them next year.

As if that weren't enough, Korean giant Samsung Semiconductor has recently run afoul of the International Trade Commission (ITC), thanks to its reluctance to settle a patent infringement suit filed by TI. The ITC is recommending an exclusion order on Samsung's 64K and 256K chips and all equipment containing those parts. If President Reagan agrees to the ITC's recommendation, U.S. chip buyers could stand to lose one of this country's top five 256K suppliers. Another loser in this arrangement could be Intel, which has an agreement to sell Samsung's memory chips — including an as yet undisclosed 1Mb memory chip. Intel appears undaunted, however: "It's business as usual," says a spokesperson.

If Toshiba were banned from selling in the U.S., Motorola would lose its 1Mb supplier *and* U.S. buyers would lose access to almost 32% of total production

Perhaps the bottom line on the shortages, if they can be separated from the international events surrounding them, is that new technology always takes longer to develop, produce, and reach volume with, than the engineers think it will. Despite accusations from both sides of the Pacific Rim about dragging of feet, stockpiling and price inflation, the truth may be that 1Mb DRAMs are just very difficult to produce in volume over a short period of time.

Why are producers taking so long to ramp up? More complex technology is most often the answer. State-of-the-art fab capacity is required, and the geometries are smaller as well. TI, for example, is shipping a 1-micron 1Mb chip now. Also, the 1Mb chip is really stretching the existing 256K technology, engineers say. TI and NEC chose not to work with existing production methods but instead went with their own "trench" technology, a three-dimensional technique that permits much greater chip densities. And development of such a new technology always takes longer.

NEC, which is just now entering the 1Mb market, says it has taken its time for a good reason. "We are planning for the future," says John Marck, vice president and general manager of Memory Products Division. "It's taken quite awhile to develop our trench technology, but it is the acknowledged technology of the 4Mb chip, and we will have a jump on the future."

VALERIE RICE

KEEPING AMERICA COMPETITIVE

CELLULAR PHONES

Calling all competitors: Motorola just got tough

Motorola flexed legal muscle and manufacturing might to win back cellular phone supremacy — so now Japan makes phones in the U.S.

By Norm Alster

Cellular mobile telephones have begun to revolutionize personal and business communications. But the cellular telephone manufacturing industry itself has undergone tumultuous change in the past two years. Catalyst for much of that change — directing the flow of events both publicly and behind the scenes — has been . . . pioneer Motorola Inc.

Motorola is not the powerhouse it used to be in the cellular phone business. But it is the major U.S.-headquartered survivor in the industry and in the past year it has more than held its own among three or four tightly bunched U.S. market leaders.

Motorola executives proudly credit their recent market success to new manufacturing efficiencies and quality improvements. With laudable gains in inventory turns, cycle time and defect-free product, Motorola's manufacturing efforts can rightfully claim a role in the cellular division's performance.

But there is a lot more than cycle time to Motorola's story. Aggressive legal and political tactics have been every bit as important in enabling the company to stay competitive in a market targeted by virtually all the Japanese electronics heavyweights. Never the silent suffering type, Motorola has complained long, hard and bitterly about Japanese trade practices. But more recently, Motorola's twitching and moaning have been backed up by effective action. The company has turned to its lawyers, the U.S. government and the courts to protect its market position and intellectual property.

In so doing, Motorola has saved its own cellular business and also turned the entire cellular industry upside down. The cellular phone business today bears little resemblance to that of 1984. Whereas just three years ago, Japanese manufacturers were drowning U.S. manufacturers in a flood tide of exports, today almost all manufacturing of cellular telephones is either based in the United States — or headed that way. And many of Motorola's most powerful overseas rivals now pay tribute to the pride of Schaumburg, Ill.

ELECTRONIC BUSINESS *has learned that several major Japanese manufacturers have agreed to pay royalties to Motorola in order to duck patent infringement charges. Firms which have refused such payments now face Motorola lawyers in court. This is the story of an American company that has learned to play industrial hardball.*

It was a grim situation that faced Motorola in the fall of 1984. Cellular telephone prices were in free-fall as Matsushita, Mitsubishi, NEC and others struggled to unload bulging inventories in what was then a slowly developing market. Prices were in "a terrible spiral downward," according to Eric Nelson, an analyst with the U.S. International Trade Commission. They were falling so fast, Nelson ex-

PAPER CHASE: Motorola's legal onslaught has generated a blizzard of documents. Among the claims filed against competitors were anti-dumping petitions to the U.S. International Trade Commission and Commerce Department.

plains, that customers simply stopped buying on the expectation that prices would be lower the next week. Almost invariably, they were.

In November of 1984, Motorola filed petitions with the U.S. International Trade Commission and the Department of Commerce, charging Japanese manufacturers with dumping cellular telephones in the United States. "The Japanese manufacturers are apparently intent upon taking over the U.S. cellular mobile telephone market, no matter what it takes. . . . Virtually all of the prices charged by Japanese manufacturers are at less than fair value," Motorola argued in its antidumping petition.

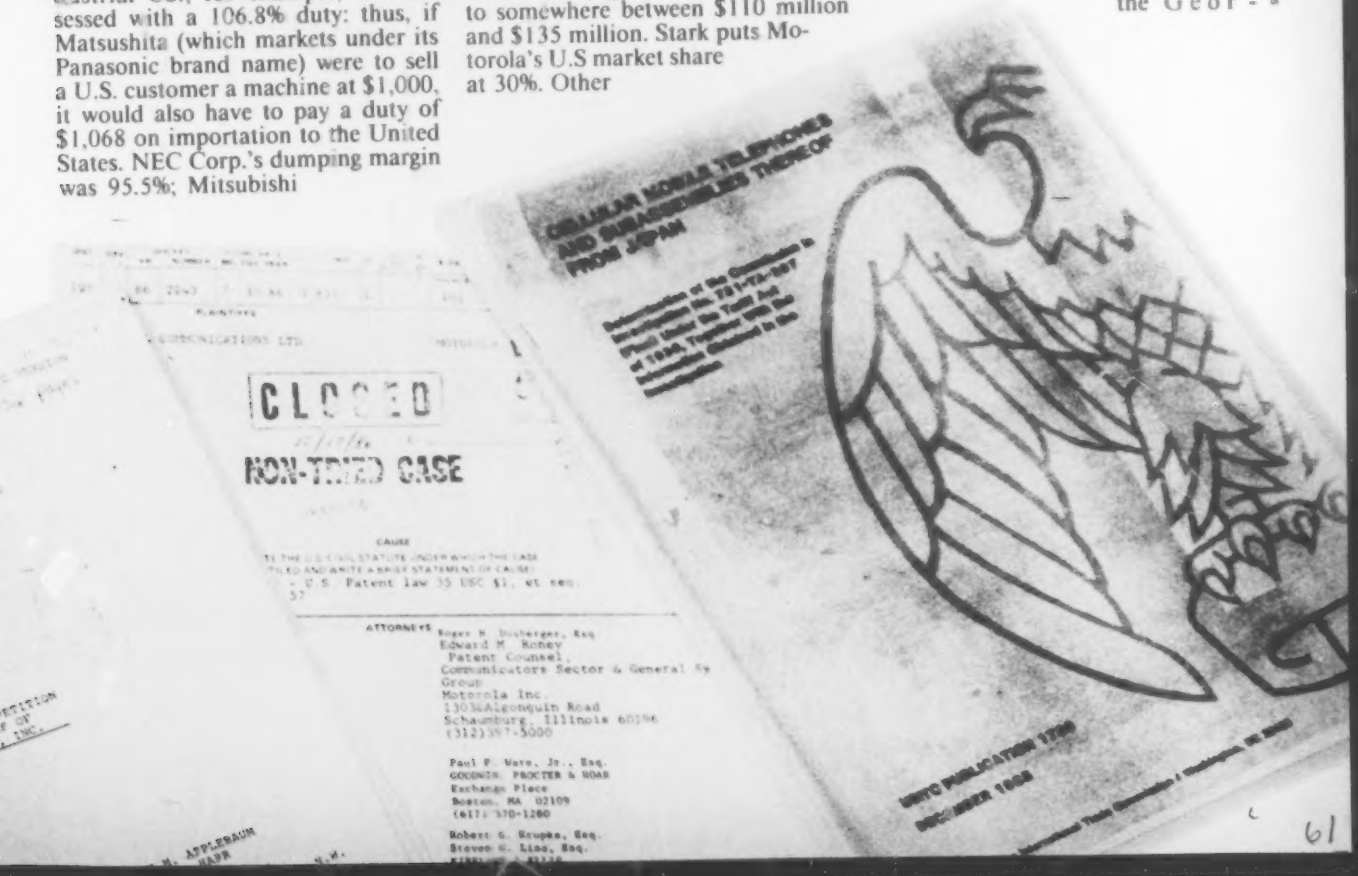
The International Trade Commission supported Motorola's contention that U.S. industry had suffered harm and the Department of Commerce, after concluding that the Japanese were selling cellular phones in the United States at significantly lower prices than they were selling them in Japan, imposed duties on Japanese product. The penalties were stiff. In some cases, they approached or even exceeded the prices for the telephones themselves. Matsushita Electric Industrial Co., for example, was assessed with a 106.8% duty: thus, if Matsushita (which markets under its Panasonic brand name) were to sell a U.S. customer a machine at $1,000, it would also have to pay a duty of $1,068 on importation to the United States. NEC Corp.'s dumping margin was 95.5%; Mitsubishi

International Corp.'s, 87.83%.

As a result of these actions, prices began to stabilize. Although the ITC action came too late to revive the floundering cellular businesses of E.F. Johnson, General Electric Co. and Harris Corp., Motorola survived. And in the past year or so, Motorola has come on strong, either matching or exceeding industry growth rates of 20% to 25%. Michael Stark, an analyst with the San Francisco investment banking firm of Robertson, Colman and Stephens, estimates that Motorola's U.S. sales of cellular radios actually grew by 50% last year to somewhere between $110 million and $135 million. Stark puts Motorola's U.S market share at 30%. Other analysts put it closer to 20%. According to Dataquest Inc., the U.S. cellular telephone market has matriculated from $21 million in 1983 to $285 million this year and is headed for a projected $343 million in 1988.

The antidumping suit was clearly a boon to Motorola. It also had a chilling effect on a number of Japanese producers. NEC and Panasonic were particularly hard hit, falling from front-runner to distant also-ran status in the last two years. But these were only the more obvious consequences of the Motorola suit.

It is not often that whole industries experience continental shifts. Rarer still are shifts that carry industries from Asia to America. And yet today, Motorola's major Japanese rivals have either wholly transferred or are in the process of transferring their cellular phone production from Japan to the United States. Oki Telecom, by most accounts in the top four (along with Motorola, NovAtel Communications Ltd. and Toshiba America Inc.) of cellular manufacturers, builds all its cellular phones in Norcross, Ga. Oki actually exports the Geor-



Cover illustration: Gary Hallgren. Rights to Dick Tracy character: Tribune Media Services

gia-built phones to Hong Kong, New Zealand and Australia. Toshiba expects to meet all its U.S. market needs for cellular phones with U.S.-manufactured product by 1989. Mitsubishi and Panasonic claim to make all (except their duty-exempt portable models) cellular phones here: Panasonic in Chicago and Mitsubishi in a Braselton, Ga., plant that is expected to turn out 60,000 units a year. NEC manufactures in Hawthorne, Calif., and Hillsboro, Ore.

There have been rumors that some Japanese manufacturers ship cellular phone subassemblies to places like Singapore for assembly and duty-free entry to the United States. This subterfuge is called "trans-shipments" and Anne D'Alauro, U.S. Commerce Department import compliance specialist, cautions scofflaws that her department is "very much aware" of the problem. But it is unlikely that these amount to a substantial share of the radios sold in the United States. Actually, with the exception of the handheld portables (which represent perhaps 10% of the market and are exempt from duties) and Toshiba's current output (which will soon be switched to the United States) very few radios are still manufactured in Japan for sale in the United States.

OPERATIONS CHIEF EDWARD STAIANO (front) claims Motorola has been so successful in reducing parts count that its new radios have roughly half the parts of those made by Japanese rivals. **PRESIDENT JOHN MITCHELL** (rear) welcomes rival Japanese producers to the U.S. — as long as they're not subsidized

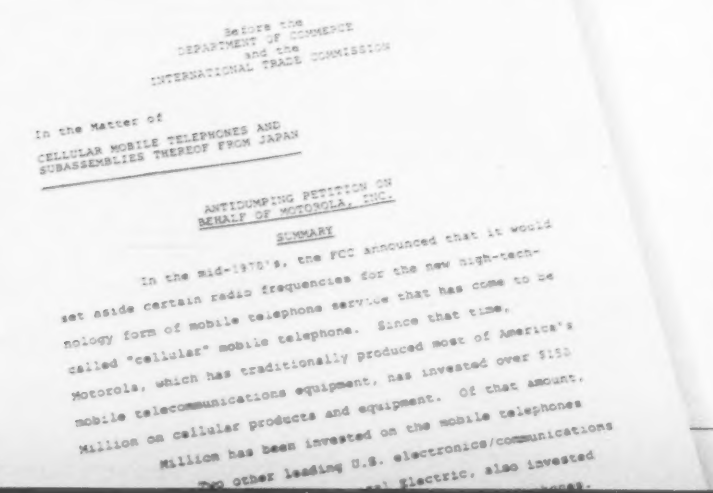
Skirting duties

By producing in the United States, the Japanese sk[illegible] the dumping duties. But there are other reasons Japanese firms have chosen to relocate manufacturing in the United States. According to industry insiders, foreign manufacturers were offered a choice by Motorola: either pay royalties or face patent infringement charges in court. Toshiba, for example, opted to pay the royalties. Interestingly, says Louis Antoniou, vice-president of the mobile communications division of Audiovox, sole U.S. distributor for Toshiba's cellular phones, the offer included a two-tier royalty schedule. Antoniou says the royalties on phones manufactured in the United States are "a little bit less than one-third as much as the royalty for Japanese production."

Toshiba vice president Ichiro Tajima says that one factor in his firm's decision to relocate manufacturing in the United States was the lower level of royalty payments. Tajima, while acknowledging that royalty payments by Toshiba to Motorola "have begun," would not disclose any details on the level of payments.

Oki Telecom vice president for marketing and strategic planning Anthony Russo reports that Motorola's approaches to Japanese companies "started well over a year ago. . . . They have gone to a few companies . . . I know they approached a few Japanese companies." Russo would neither confirm nor deny that Oki was paying royalties to Motorola. Motorola declined to name the companies it has licensed, although documents filed with the International Trade Commission reveal that four companies were licensed by Motorola between December of 1986 and April of 1987.

To put Motorola's actions in perspective, it is worth noting that its U.S. semiconductor brethren — nota-



Before the
DEPARTMENT OF COMMERCE
and the
INTERNATIONAL TRADE COMMISSION

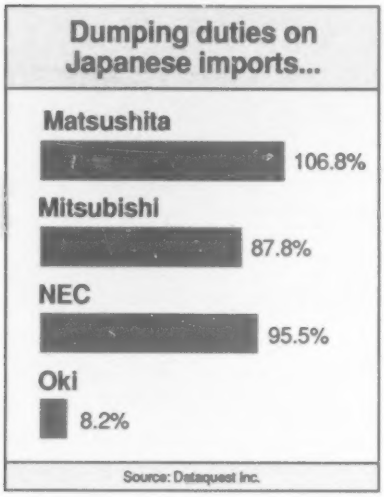
In the Matter of
CELLULAR MOBILE TELEPHONES AND
SUBASSEMBLIES THEREOF FROM JAPAN

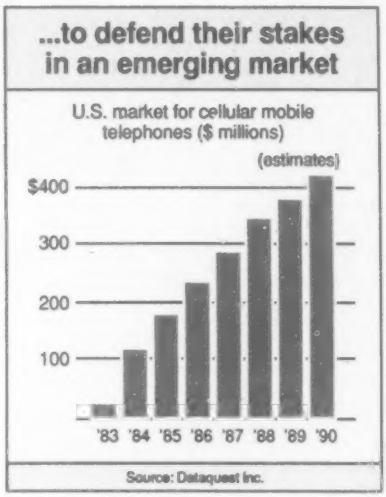
ANTIDUMPING PETITION ON
BEHALF OF MOTOROLA, INC.

SUMMARY

In the mid-1970's, the FCC announced that it would
set aside certain radio frequencies for the new high-tech-
nology form of mobile telephone service that has come to be
called "cellular" mobile telephone. Since that time,
Motorola, which has traditionally produced most of America's
mobile telecommunications equipment, has invested over $150
Million on cellular products and equipment. Of that amount,
Million has been invested on the mobile telephones
Two other leading U.S. electronics/communications
[illegible] Electric, also invested

Michael Abramson





bly Intel Corp. and Texas Instruments Inc. — have also shown stiffened resolve in seeking legal and governmental protection for what they deem to be proprietary technology. And the willingness of Japanese companies to agree to royalty payments may well reflect the merit of Motorola's claims. Although some Japanese executives claim these decisions are simply good politics — avoiding legal entanglement and adverse publicity at a time that the U.S. government and public show increasing impatience on international trade issues — they also issue from Japanese calculations on their chances of besting Motorola in court.

But why would Motorola assess U.S.-built product with lower payment levels than Japanese-built? Antoniou offers one explanation: "It's one way for Motorola to force the firms to come in to the U.S." Interesting, indeed. It's one thing for a company to publicly wrap itself in the flag. But could patriotic sentiment actually guide Motorola's hush-hush licensing negotiations? Not hardly, according to Antoniou. Motorola has a more practical interest in bringing the Japanese onshore. "That way Motorola will have a better chance to compete," Antoniou reasons.

Motorola president John Mitchell says he is unaware of any two-tier royalty schedule. But Mitchell does say that he is pleased to have the Japanese in the United States: "Frankly, we welcome that. We have found over the years that we can compete on a level playing field. If they're making product in this country. And we're making product in this country. And we're all buying components from around the world — that's about as level as you can make the playing field. As long as there isn't cost subsidization."

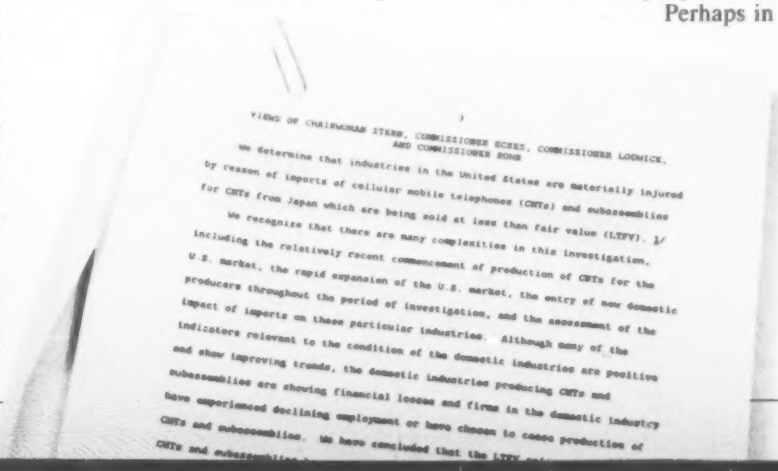
It will be interesting to see how competitive Japan's U.S.-based operations will be. Tomozo Yada, director of manufacturing at NEC America's Hillsboro, Ore., plant, claims NEC's U.S. efficiency is "the same as Japan — almost." Quality, too, is "almost as good" as in Japan. Toshiba vice president Tajima was asked if his company's cellular operations can manufacture as efficiently in the United States as it can in its home base? "To be honest with you, we don't know," he concedes.

Border dispute

But there is one foreign producer that Motorola has not yet managed to swing into the continental United States. That producer is Canadian — Calgary-based NovAtel Communications Ltd. — and it is now locked in legal battles with Motorola. In July, Motorola filed a patent infringement case against NovAtel with the International Trade Commission. Motorola, claiming it has been hurt by NovAtel, particularly in the low end of the U.S. market, asks the ITC to grant "a permanent exclusion order" on Novatel products. Another case in which the companies are trading charges and counterclaims is scheduled to be heard early next year in Chicago.

"Motorola approached us in March of 1986. They claimed we were violating a number of their patents. . . . They wanted us to pay royalties to them," recalls Delbert Lippert, president of NovAtel. Stephen Chow, attorney with Cesari and McKenna, the Boston law firm that represents NovAtel, says that NovAtel chose to go to court rather than to pay royalties to its cross-border rivals. "They were asking very large royalties," Chow contends. Lippert says NovAtel weighed the costs of litigation versus the costs of being licensed by Motorola. "The cost of the license was not cheaper than the cost of the litigation," says Lippert. Although Lippert would not disclose the actual royalty levels asked by Motorola, he does say that the U.S. company has held firm on its royalty demands.

Perhaps in an-


VIEWS OF CHAIRWOMAN STERN, COMMISSIONER ECKES, COMMISSIONER LODWICK, AND COMMISSIONER ZONE

We determine that industries in the United States are materially injured by reason of imports of cellular mobile telephones (CMTs) and subassemblies for CMTs from Japan which are being sold at less than fair value (LTFV). 1/

We recognize that there are many complexities in this investigation, including the relatively recent commencement of production of CMTs for the U.S. market, the rapid expansion of the U.S. market, the entry of new domestic producers throughout the period of investigation, and the assessment of the impact of imports on these particular industries. Although many of the indicators relevant to the condition of the domestic industries are positive and show improving trends, the domestic industries producing CMTs and subassemblies are showing financial losses and firms in the domestic industry have experienced declining employment or have chosen to cease production of CMTs and subassemblies. We have concluded that the LTFV

ticipation of patent infringement charges by Motorola, NovAtel went to court to invalidate two key Motorola patents. Motorola swiftly countersued, claiming violation of four of its patents. The rival claims will be adjudicated in the Federal District Court in Chicago. Also named in the ITC suit are Hyundai Electronics Industries Company Ltd. of Korea and Astec International of Hong Kong. These two firms assemble most of the transceivers (which account for 75% to 85% of cellular phone value) for the NovAtel phones. Having uprooted the Japanese cellular business, Motorola is now in a position to short-circuit nascent cellular operations in Korea and Hong Kong.

With Motorola's rivals either paying royalties or legal defense fees or pitching tents on a level playing field of Motorola's choosing, it would seem that the firm's legal tactics have been an unequivocal success. But this is not necessarily the case.

It is, after all, the free trader's argument against protectionism that ultimately the weak competitor will fail anyway. Indeed, artificial protective barriers such as duties are thought to discourage the sort of energetic self-improvement that is instigated by unfettered competition. But Motorola appears to be well aware of this trap.

One U.S. trade official who has been involved in a number of dumping cases says that many U.S. companies have won dumping battles only to lose the longer term competitive wars. Motorola, he says, has both won (cellular phones and tone-only pagers) and lost (display pagers) such cases, but has always managed to benefit from the nine- to 12-month price stabilization that all such dumping cases have historically provided. During that period of respite, the official

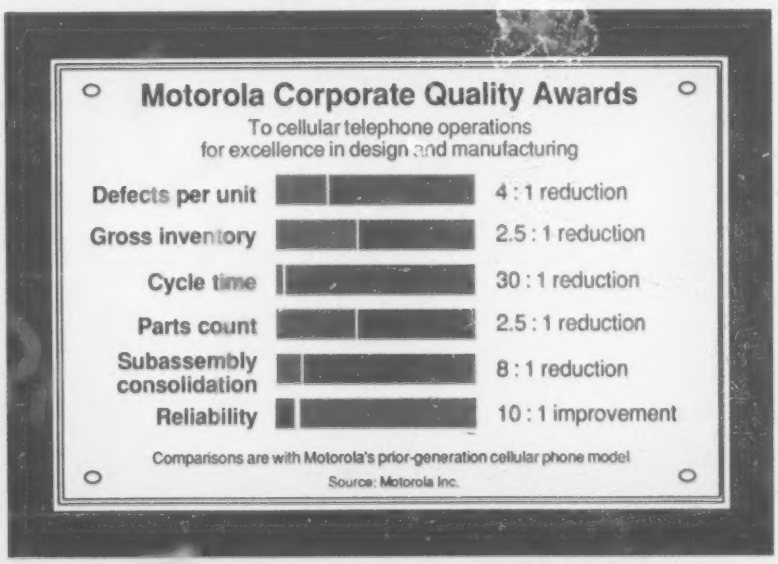
Scaling the Everest of quality

Motorola Inc. certainly had ample incentive to improve the quality of its cellular products. The company's early models had acquired a rather spotty reputation. Victor Spence, director of electronic data processing for Cellular One, a cellular telephone operator based in the Washington-Baltimore metropolitan area, says it was commonly known that Motorola "had quality problems" with its early units. Indeed, Susan Liebeler, vice chairman of the International Trade Commission (and the only ITC commissioner to vote against imposing dumping penalties) cited "the relatively high failure rate reported by some purchasers of Motorola's cellular mobile telephones."

But today even competitors acknowledge that Motorola's products have improved in quality. "I think they have a pretty good unit in terms of quality and reliability," observes Katsumi Fujii, general manager for the communications equipment sales division of Mitsubishi International Corp. Toshiba America Inc. vice president Ichiro Tajima describes Motorola as "price-wise competitive and quality-wise competitive." "Recently I don't hear any failures [of Motorola phones] reported," concurs Stacy Ogawa, assistant general manager for Panasonic Industrial Company's telecommunications division.

Motorola's top brass has recognized the accomplishments of the cellular phone operations. Three of 10 corporate CEO awards — Motorola's highest internal quality accolade — presented this year have gone to cellular. In designing its new Mini-Tac phone, the group was able to reduce parts count by 66%. In building the new units on a small lot just-in-time manufacturing line, cycle time was compressed by 98% and work-in-process levels flattened by 80%, according to Daniel Przybylski, senior manufacturing operations manager. Inventory is being turned five times as fast. "We're zeroing in on 20 turns," beams Edward Staiano, vice president of the General Services division that embraces cellular phones.

Like quality leaders Hewlett-Packard Co., IBM and Xerox Corp., Motorola has evolved its own mix-and-match formula blending the five core disciplines of quality improvement [ELECTRONIC BUSINESS, Jan. 15, 1987]. The emphasis is on implementing small lot manufacturing dependent on just-in-time supplier deliveries. Statistical process control and problem-solving methodology are applied to identify process problems and keep production within ever more tightly defined process parameters. Because the quality of supplied components must be very high, systems companies like Motorola have thinned supplier ranks, rewarding those that can implement suitable



THE CELLULAR DIVISION actually won three Chief Executive Officer awards — Motorola's highest internal accolade — for accomplishments summarized above

(who requested anonymity) explains, Motorola works hard to trim production costs.

Motorola executives contend that they have made this sort of progress in their Arlington Heights, Ill., cellular manufacturing operations (see accompanying article). In emphasizing design manufacturability and in implementing small lot short-cycle production, the cellular operations are said to have engineered impressive reductions in parts count, defect levels and labor costs per unit. The result is an operation which is "earning well," according to Mitchell. Vice president and cellular operations chief Edward Staiano, while declining to break out details on cellular's profitability, claims that "the corporation is very happy with our profit."

It's probably still too early to conclude that Motorola's manufacturing achievements have ensured its long-term leadership in a market that continues to attract powerful new participants each year. But the short-term picture is certainly in clear focus. Motorola can now enjoy the home-court advantage on a level playing field it has single handedly managed to bulldoze. □

If your company has received an award as a quality supplier, ELECTRONIC BUSINESS would like to know. If your company gives annual awards to its outstanding electronics suppliers, we would be interested in a list of winners. Awards should be for performance in 1986 or 1987.

Send details to:

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Newton, Mass. 02158

controls on their own product with bigger chunks of their business. Suppliers — as well as production personnel — are often involved in the early stages of product design to insure that the designs can be both produced and sourced as specified.

The highest quality

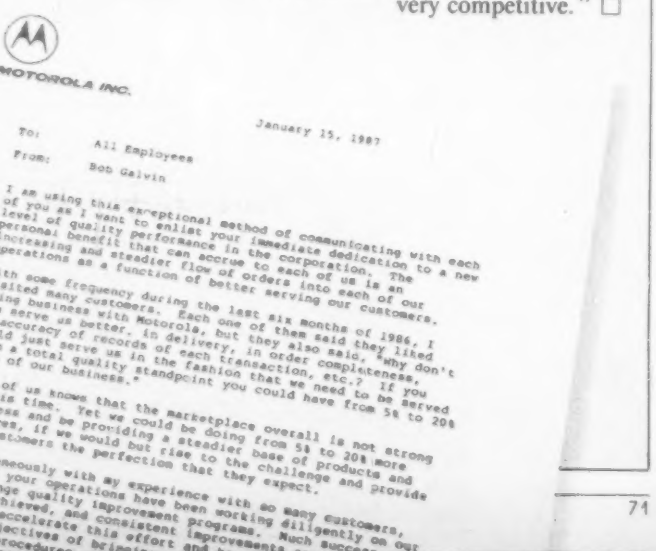
Motorola's corporate objective is to produce parts with a remarkable 99.9999998% conformance to specifications by 1992. This statistically derived Everest of quality is termed 6-Sigma. By contrast, at the sea level of 1-Sigma, which represents the standard deviation from mean, fully 32% of parts could be expected to fall outside specified parameters. Ten or 15 years ago, recalls Robert Carstens, manager of quality assurance for cellular phones, 3-Sigma was pretty much the standard in electronics manufacturing. At 3-Sigma almost 7% of parts fall outside specs. But the air is now getting awfully thin. Motorola president John Mitchell says that the cellular group is currently "very close to 5-Sigma (or 99.9999% conformance)."

Parts count reduction and equipment optimization have contributed to the cellular group's progress to date. Staiano claims that Motorola has been so successful in reducing parts count that the new Motorola radios have roughly half the parts of those made by Japanese rivals. Reduced part count has implications for quality. Since the number of defects in a system is a product of the defect levels in its components, lower parts count (so long as there is uncompromised component quality) should mean more failure-free systems.

Production managers in Arlington Heights, Ill. — where the radios are assembled — are proud of their ability to tweak performance levels of older equipment. "We did not fall into the trap when we started the program of simply going to the catalogs and buying the latest and the greatest," says Przybylski. Instead, older machines are coaxed to higher performance through hardware modifications, continuous software improvements and preventive maintenance. Przybylski estimates that most users of first-generation Panasonic surface mount component chip insertion equipment typically suffer placement misses on something like 800 of every 1 million parts. But the cellular group has cut down errors to "well under 200 parts per million." Przybylski says he buys new-generation equipment only when he's convinced that a machine "is running the best it's ever run and that we can't get it to run any better."

Staiano says one key to production performance is finding people at each station who are "in love with" their machines. Since love is precious but sometimes hard to find, management also enlists the aid of a more common commodity: self-interest. Worker compensation is based on the number of operations an employee has mastered. Because JIT production systems operate with low inventory and minimal work-in-process, it is important that production continues no matter who fails to show up for work. Hence, the value of employees with cross-functional expertise.

For all the apparent accomplishments in Arlington Heights, rumors persist that Motorola may move its cellular operations offshore. No way, says president Mitchell. If anything, he claims, cellular could serve as the model for more U.S. plants. "We see lots of opportunity to do more of the things we did in the cellular activity. And that is to build a focused, dedicated short-cycle factory in this country and be very competitive." □



MOTOROLA INC.

January 15, 1987

To: All Employees

From: Bob Galvin

I am using this exceptional method of communicating with each of you as I want to enlist your immediate dedication to a new level of quality performance in the corporation. The personal benefit that can accrue to each of us is an increasing and steadier flow of orders into each of our operations as a function of better serving our customers.

With some frequency during the last six months of 1986, I visited many customers. Each one of them said they liked doing business with Motorola, but they also said, "Why don't you serve us better, in delivery, in order completeness, in accuracy of records of each transaction, etc.? If you would just serve us in the fashion that we need to be served from a total quality standpoint you could have from 5% to 20% more of our business."

Each of us knows that the marketplace overall is not strong at this time. Yet we could be doing from 5% to 20% more business and be providing a steadier base of products and services, if we would but rise to the challenge and provide our customers the perfection that they expect.

Simultaneously with my experience with so many customers, many of your operations have been working diligently on our long-range quality improvement programs. Much success is being achieved, and consistent improvements are being made. We must accelerate this effort and bring our long-range objectives of breakthrough improvements as a regular procedure of performance

ATE

Schlumberger tests its new European ATE accent

Its record in electronics does not sparkle, yet Schlumberger claims ATE success in Europe. Same again, please, in the U.S.

By Jack Gee

Schlumberger Ltd., the New York-based oil and electronics conglomerate, has been in the news too often lately for the comfort of its management. Its name has rarely been visible in the headlines. But grim columns of print about the misfortunes of its subsidiaries are alarming stockholders.

Some of the most disconcerting news surrounds the electronics activities of Schlumberger, the world's largest oil-services company. Earlier this year, after being hounded by protests from the flag-waving U.S. computer chip industry and by President Reagan's administration, the company scrapped a plan to sell its Fairchild Semiconductor Corp. to Japan's Fujitsu Ltd. For awhile, it looked as if Schlumberger might be stuck with the dollar-draining chip maker. But then, National Semiconductor Corp. agreed to purchase Fairchild.

Schlumberger today has grounds for asking whether it made a major strategic error in getting into the chip business when, in 1979, it bought the already ailing Fairchild. Critics might ask whether the company was right to dabble in electronics at all: its records in automatic test equipment and CAE/CAD/CAM markets are nothing to write home about either. Kenneth Neff, vice president of San Jose market research firm Prime Data Inc., shows Schlumberger's share of worldwide ATE markets sagging: from a peak of 26% in 1979 to just over 13% last year.

But D. Euan Baird, 50, who was named chairman, president and chief executive of the conglomerate a year ago, clearly still has hope for his tester and CAD/CAM operations — especially in Europe, where Schlumberger executives lay claim to half of the chip-test segment as well as leadership in Britain's military board-test market. Shortly before the Fairchild sale, Baird set up a new management group — Schlumberger Technologies — to coordinate the company's test and CAD/CAM units.

MICHEL GOUILLOUD is the lucky executive in charge of Schlumberger's electronics interests. He wants the group to perform as well in the U.S. as he says it does in Europe

> In Europe, Schlumberger executives lay claim to half of the chip-test segment

The new group is headed by corporate vice president Michel Gouilloud from headquarters in Sunnyvale, Calif. The France-born manager, who has spent 30 years with Schlumberger, runs a mini-empire that spans Sentry, which specializes in test equipment for semiconductors and integrated circuits; Factron, whose technology is applied to testing printed circuit boards; and Applicon, which produces software and hardware for computer-integrated manufacturing (CIM). Gouilloud is also responsible for Benson, a leader in computer-graphics hard copy equipment for plotting integrated circuits and printed circuit assemblies, and for Schlumberger's instruments companies, Solatron, Adret Electronique and Enertec. The bulk of this trio's activities is concentrated in Europe.

Also under Gouilloud's direction are the Schlumberger Research Laboratory, at Palo Alto, Calif., which de-

velops new technology for all these products, and Nissec, which provides sales, service and support in Asia for Schlumberger Technologies.

Gouilloud would like to see Schlumberger Technologies perform as well in the United States as in Europe, where he claims that Sentry and Factron together control 30% of overall ATE equipment sales. He reports that Sentry is now breaking even in the United States, although it still faces a long haul before rivalling its performance in Europe, where he describes it as "super profitable." He adds: "Factron and Applicon are also profitable in their European markets. In Asia — except for Japan — all the companies of our Technologies division are profitable. And, in the U.S., they are picking up after a lengthy period of sustained losses."

Observers give the Gouilloud group a chance. Neff of Prime Data says: "In putting all its ATE activities under one person, Schlumberger can expect to give this sector of its business more weight and better synergy. It can look forward to better utilization of its resources — and this certainly will not hurt."

Gouilloud endorses this theme enthusiastically. "The new organization will enable us to marshal our resources more effectively. It will work in complete synergy with the other units of our company," he says. It's not the first time that the industry has heard that. Schlumberger Technologies had a predecessor: in late 1983, the corporation created the Computer Aided Systems group to do much the same thing, but CAS never produced startling successes.

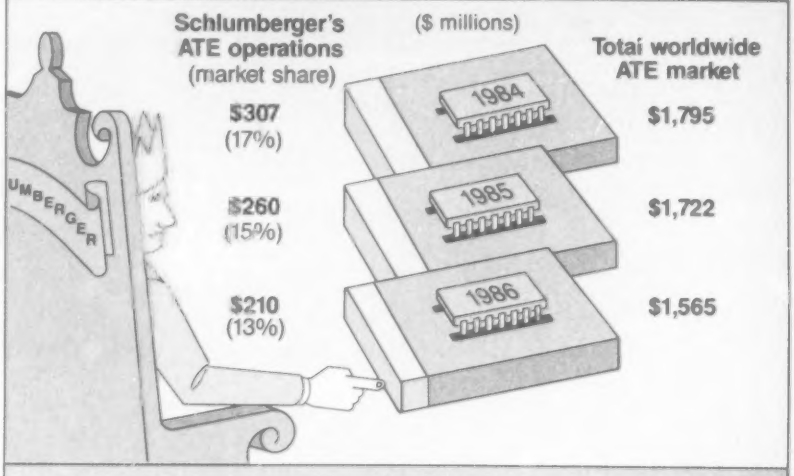
Centralizing production

Schlumberger Technologies comes with one tangible difference: a $35 million Advanced Manufacturing Center that will centralize the production of the ATE operations in one facility instead of three. Industry analysts view this as a signal that Schlumberger's ATE units are not as profitable as they make out to be. Says Stephen Balog, who follows this sector for Prudential-Bache Securities Inc. in New York City: "They can't be doing real well, or they wouldn't be consolidating. You don't do that if you're busting at the seams."

However, he believes the new manufacturing plan is a good business decision: "It shows, without a doubt, that Schlumberger is in it for the long run. If they were going to sell [the ATE operations], there's no way they would spend that kind of money," he reasons.

The new structure is currently being put into place on both sides of the Atlantic and across the Pacific. In Europe, where the semiconductor slump has bitten less painfully than in the United States and Japan, Schlumberger's ATE operations may fare better. Explains Prime Data researcher Neff: "In 1986, Europe was strong relative to the U.S. ATE buying held up, and Schlumberger participated in that strength. But every ATE company was helped out by European buying." However, Neff adds that the company did no better overseas than its U.S. competitors.

Schlumberger has hardly had the Midas touch with ATE



Source: Prime Data Inc.

> Britain alone accounts for half of Factron's sales in Europe

Gouilloud claims that Schlumberger is better placed than its competitors in ATE because its presence is more widely spread around the globe. He says: "We have the world's best territorial coverage. It's not only because we have plants, engineering and research groups in the U.S., Europe and Japan. Equally significant is Schlumberger's long tradition as a multinational company."

In Europe, Factron designs and produces board testers at a plant in Ferndown, England, while Sentry's components testers are produced in Saint Etienne, France. "Both plants are closely linked, not only with the history of Schlumberger, but with that of European ATE," says Gouilloud.

Factron's British operation is the successor to Membrain, a British company specializing in functional ATE, which Schlumberger acquired in 1970. Its name was changed to Factron in 1984 in order to identify it more closely with Schlumberger's U.S. products. "The idea was to convey the philosophy of the company more effectively," says Jeff Pitman, vice president and general manager of Factron, Europe. However, the Membrain name is still used on some of Factron's British equipment.

Military traditions

The Membrain tradition also explains why Britain alone accounts for half of Factron's sales in Europe. Pitman says: "We are particularly strong in Britain because we are the No. 1 supplier of ATE equipment to the British military market."

In Saint Etienne, the present site of the Sentry plant was occupied by an instruments test equipment factory when Schlumberger took over Fairchild's assets in 1979. Jean-Pierre Longere, vice president and general manager of Sentry, Europe, says: "Fairchild already had people working on ATE at this French facility. Schlumberger decided to turn the plant into a full-scale chip test manufacturing center in order to be close

to Europe's semiconductor manufacturers."

Longère explains: "That is why Sentry's S15 20-megahertz tester was originally designed and marketed in Europe, although it is now also being manufactured in the U.S. and, later, will be made in Japan. We believe we have an edge on our competitors because our customers are close to our plants."

The growth of the European workforce at Sentry and Factron contrasts with the reduction of personnel in the United States. In 1980, 300 people were employed at the European plants. Today they number 680. In the United States the workforce at Schlumberger Technologies is now 4,000 fewer than a year ago.

Europe's total available market for chip testers was estimated at $43 million last year by industry analysts. "We have captured half of that market," claims Sentry's Longère. He adds: "We have the advantage of being the only major production center in Europe for very large scale integrated circuit [VLSI] testers."

Stressing the importance of industrial and marketing presence in Europe, Robert J. Valentine, vice president and manager of Schlumberger's Factron division, says: "Schlumberger is committed to being a success not just in technology but also in its local environment. That's why our visibility in Europe is so important. It also means that we have to answer the specific needs of our European customers just as we respond to those in the U.S. and Japan by developing software and engineering know-how to meet their requirements."

> "The wave of mergers between European semiconductor companies confronts us with a challenge"
>
> Jeff Pitman of Factron, Europe

Valentine adds: "More and more customers want to take Sentry-Factron solutions together as a package. As Europe's semiconductor firms consolidate, they are likely to be conservative in investing in new test equipment until they put into operation their long-term plans."

After shrinking by almost 20% over the past three years, Europe's board level ATE business is now on the upturn. Pitman comments: "It won't grow as fast as in the boom years, although chip manufacturers are reporting a recovery. The wave of mergers between European semiconductor companies confronts us with a challenge. We have to be particularly sensitive to the demands of the new groups created by the alliances between ITT Corp. and France's Compagnie Générale d'Electricité; Thomson Semiconducteurs with Italy's SGS Microelettronica; and also between Britain's General Electric Co. and Plessey Co. Plc in developing the System X central office switch. Factron has long counted L.M. Ericsson, France's Matra and Compagnie Générale de Constructions Téléphoniques among our customers. Now we hope to be able to supply CGCT under its new Ericsson-Matra management."

Revolution or tea party?

Pitman believes that the advent of computer-integrated manufacturing will "make Europe's earlier Industrial Revolution look like a tea party." He adds: "That's why organizations like Schlumberger Technologies have to provide new resources and intellectual information to help our customers through. ATE suppliers have to be increasingly able to adapt to a more and more competitive marketplace."

Looking at the global picture, Gouilloud says: "Schlumberger's ATE customers have three major matters of concern. These are the emergence of the Japanese semiconductor industry, their own excess plant capacity and also quality. In fact, customers' concern about quality is the result of the convergence between the Japanese challenge and the incredible complexity of modern VLSI chips."

Gouilloud adds: "VLSI sets a mammoth problem for ATE manufacturers in design and testing because of the huge number of transistors now sitting on a chip. The technology leap between the ATE systems of 10 years ago and those of today is bigger than that between designing a Beechcraft [light airplane] and a Boeing 747."

However, he says he is convinced that Schlumberger can meet chip manufacturers' demands because it can draw on vast software expertise in its own ranks to solve the new design and test problems. But he admits: "The sale of Fairchild will deprive us of our immediate access to semiconductor knowledge inside our own company. In the future, we shall depend more on information from other chip manufacturing firms. However, even if our relationship with Fairchild is not as comfortable under its new owners, I hope Fairchild will stay close to us."

> "The sale of Fairchild will deprive us of our immediate access to semiconductor knowledge in our own company"
>
> Gouilloud of Schlumberger Technologies

Gouilloud also stresses the need for Schlumberger to develop links with Japanese semiconductor firms as close as those with its ATE customers in the United States and Europe. He says: "A large share of the chip testing market is in Japan. That is why Sentry operates a plant there in Fuchinobe. We are working closely with Nippon Telephone & Telegraph Co. on software development and have sold them one of our electron-beam test machines. NTT is particularly important to us because of its size and its influence on Japanese industry with special emphasis on telecommunications. Our work in Japan enables us to help our customers elsewhere to achieve quality and cycle times that rival those of the Japanese chip makers."

The Schlumberger Technologies chief says that many of these customers are building their printed-circuit boards more efficiently than in the past. "But some have rejection rates of between 20% and 30% for their boards," he points out. "They would like to have only 5% — and the Japanese are showing them that it can be done."

Gouilloud has no illusions about the future. "Semiconductors are a difficult business to be in," he says. "But, at Schlumberger Technologies, we consider it is an exciting and worthwhile business. ATE equipment will be continuously upgraded as chip designers create denser circuits with faster clock rates. As a supplier, our task is to reduce the cost of our products so that chip makers can restore their profit margins." □

KEYBOARDS

Optimistic input: The good word on the keyboard comeback

Helped by a weaker dollar, U.S. keyboard makers are enjoying some of the best growth and profits they've seen in years

By Bruce C.P. Rayner

Coming off a three-year shakeout, most top keyboard makers are starting to see the signs of a renaissance. Led by a revival in the personal computer market, growth in the $1 billion keyboard market is expected to be between 10% and 15% for 1988.

But for those merchant keyboard makers that have survived the industry restructuring and are reporting profits again, attempts to build market share will be met by cutthroat competition — from both on and offshore and in both the custom and standard markets. Still, most players are optimistic about the future.

"The market is very bullish," insists Dan Mertens, corporate marketing manager of Key Tronic Corp., one of the industry's leaders. The Spokane, Washington-based company reported fiscal 1987 sales of just over $107 million, down from a high of $122.7 million in fiscal 1985. The signs of the uptick materialized earlier in the year, says Mertens, as Key Tronic's 1987 fourth quarter, ended June 30, was the most profitable in the last three years. Sales for 1988 are expected to be up by around 15%, he adds.

Similarly, John Overby, president and chief executive of Advanced Input Devices Inc. (AID), a $40 million keyboard maker in Coeur d'Alene, Idaho, expects sales growth of 40% in 1988 as orders from original equipment manufacturers, including AT&T and IBM, enter the production pipeline. The recovery materialized in 1987, Overby claims, pointing to 70% sales growth for the year to date. In the last 12 months, AID has added 500 additional employees and an additional 15,000 square feet of factory space. Another 25,000 to 50,0000 square feet will be added in 1988, says Overby.

HONEYWELL's TIDDENS: "We see the market for keyboards growing, not dramatically, but at a reasonable growth rate of around 10% to 15%"

Others are more conservative. "We see the market for keyboards growing, not dramatically, but at a reasonable growth rate of around 10% to 15%," says Mark Tiddens, director of marketing at Honeywell Keyboards, a division of Honeywell Inc., based in El Paso, Texas.

Tiddens says there was a resurgence in business in late 1986 as personal computer companies started to ramp up production. But by mid-1987, he adds, many of those same companies were beginning to "re-evaluate" their inventory levels with the result that there has been some "flattening" out of sales now.

Stories to tell

All of the keyboard makers that survived the market upheaval have stories to tell of the lean years of 1985 and 1986: many were victims of downsizing; some have moved offshore and some have been targets for takeovers. The industry that exists today bears little resemblance to that of 1985.

Cost cutting has been at the top of everyone's list. Simply to stay competitive with foreign suppliers, many domestic keyboard makers have adopted automation as a way to cut the high-priced domestic labor bill and, at the same time, to improve quality. Also, technologies such as membrane and conductive rubber, which supersede the older contact-switch type, are becoming more mainstream. Keyboards using these technologies have fewer moving parts and are of a simpler design which lends itself to lower cost of production. The advent of membrane technology is largely because IBM and Digital Equipment Corp. adopted it in their keyboards.

Although the worst of the market downturn is behind them now, many keyboard makers still believe that more restructuring has to take place. "Selling prices have declined by 20% for the last two years," says Syed Hasan, director of marketing with Maxi Switch, a division of EECO Inc. He claims that as long as prices continue to erode, the shakeout will continue.

In the maturing "full-travel" keyboard market — the typewriter-style keyboard used in most personal computer and terminal applications — at least five major players have disappeared in the last three years, leaving a field of about 20 companies with sales of over $8 million each: those to exit include Stackpole Corp. and General Instrument Corp. Others have benefited from this: Cortron, an Elmhurst, Ill., keyboard maker, acquired Stackpole's mechanical-contact technology and much of the company's equipment, says Kenneth

Bucheit, Cortron's sales and marketing manager.

Some diversified companies that had keyboard operations have since abandoned them. AMP Keyboard Technologies Inc., a subsidiary of AMP Inc., left the full-travel keyboard business in 1985 and is focusing instead on the flat-panel keyboard market. Flat-panel boards are used in a myriad of applications, from microwave ovens to cash registers. They also are used in personal computer touch pad applications. The prices of full-travel keyboards offered by Taiwanese and Japanese competitors drove AMP away, says Hugh Aiken, general manager of AMP's keyboard business. But Aiken is not complaining about the decision to get out of the full-travel sector. "We have done very well" in the flat-panel business, he says. Aiken puts the growth rate for flat panels at between 10% and 20% in 1987.

Takeover targets

If a company managed to survive the downturn intact, it often became a target for a takeover bid. That is how Honeywell Keyboards came into existence in January of this year. Formerly called Micro Switch, the manufacturer of both full-travel and flat-panel keyboards is now one of the top three domestic keyboard makers, says Honeywell's Tiddens. The division's engineering, marketing and administration is maintained in El Paso, but production and assembly facilities have been set up in Freeport, Ill., and Juarez, Mexico.

Even though flat panel accounts for only 10% of Honeywell's business, the market is growing at about 35% a year, claims marketing director Tiddens. Although Tiddens agrees with Aiken that the flat-panel business is a high-growth market, he complains it is very fragmented.

While Micro Switch was acquired by a U.S. company, some takeovers have come from foreign companies, resulting in radical internal restructuring. Four years ago Minebea Ltd., also known as NMB, a Japanese ball-bearing manufacturer, took over Hi-Tek, a 20-year-old Garden Grove, California-based keyboard maker. Subsequently, the Garden Grove facility was shut down and all production was moved to Thailand. Like Honeywell, NMB Hi-Tek has kept its administration, engineering and marketing in the United States to stay closer to its customers.

Similarly, two years ago, Alps Electric (USA) Inc. — a wholly owned subsidiary of Alps Electric Company Ltd. of Japan — bought out the Apple Computer Inc. keyboard facility, also in Garden Grove. Alps is still Apple's primary keyboard supplier as well as a supplier to Texas Instruments Inc., independent industry sources say.

Alps has a global strategy when it comes to the keyboard market. The main facility is in Onahama, Japan, but Alps has established plants in Britain, Korea and Taiwan. The company specializes in high-volume contract manufacturing for "the major" computer companies, says Scott Petermann, director of marketing for the OEM operations of the U.S. subsidiary.

> Although the worst of the downturn is over, many keyboard makers still believe more industry restructuring has to take place

Possibly less dramatic than closeouts and buyouts, but equally significant, is the move offshore by domestic companies. Many U.S. keyboard makers have set up assembly plants offshore, either in the Far East or Mexico. For example, Maxi Switch moved its operations from Minnesota to Phoenix in February, 1986 and has set up four assembly facilities in Nogales, Mexico. Similarly, The Cherry Corp. is phasing out its keyboard operation in Waukegan, Ill., and will target both the U.S. and European markets from its West German facility.

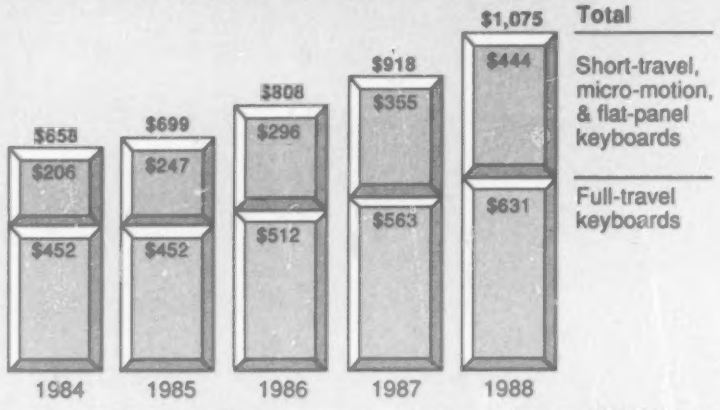
On or offshore?

While the advantages of cheap foreign labor, either in the Pacific Rim or in Mexico, appear obvious, hidden costs of maintaining these distant operations do exist: inventory is often tied up in shipping; design changes are difficult to make; and quality of assembly can be low. These issues are particularly troublesome in the custom market where customer service, both pre- and post-sale, are crucial. While the standardized market for the 101-key and 84-key IBM-compatible keyboards is growing — it is valued at around $30 million — the custom market still accounts for over 90% of all OEM business, Honeywell's Tiddens estimates.

Now that the Pacific Rim currencies are beginning to move up in relation to the U.S. dollar, the cost advantages of moving assembly offshore appear to be lessening. Low-cost producers in Hong Kong, Singapore and Taiwan that have targeted the high-volume standard keyboard market are becoming less price-competitive as their currencies begin to rise against the dollar. Mexico, however, remains an attractive alternative because of its proximity to the

U.S. keyboard makers are seeing a return to healthy business

Total U.S. merchant keyboard market from both domestic and foreign sources ($ millions)



Sources: Venture Development Corp. and ELECTRONIC BUSINESS

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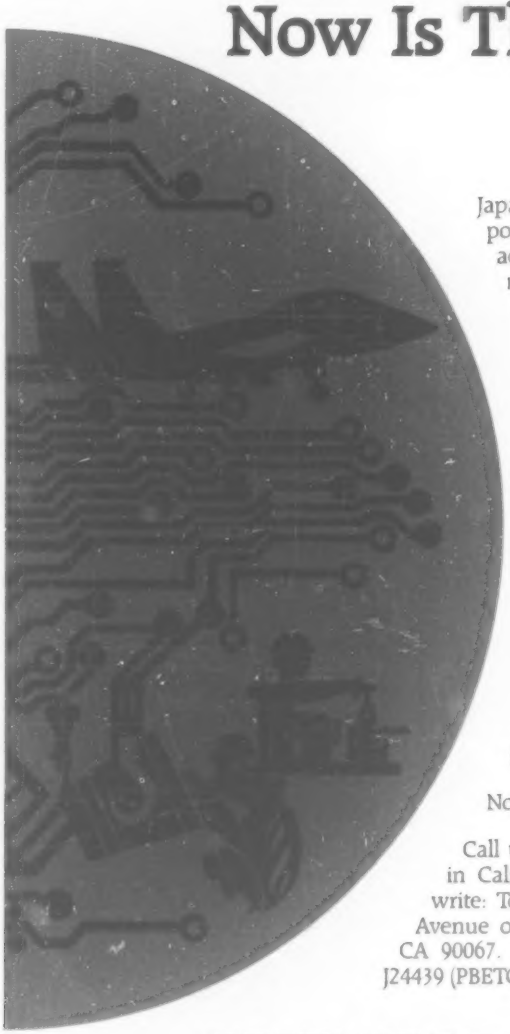

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U.S. market and the close control that a domestic manufacturer can exert. Also, many keyboard makers insist that the quality of product made south of the border is comparable to that obtained with domestic manufacturing.

While current OEM contracts with offshore vendors that are in the production phase will probably not be affected by the dollar's fall, there is expected to be some impact on new OEM business in 1988. Cortron's Bucheit says he is already seeing some OEMs that were purchasing from Taiwanese suppliers returning to domestic sources. This trend is most noticeable in the high-end product price range, he says.

As U.S. producers look to the continuation of a weak dollar for some reprieve, the trend toward a standardized market intensifies. Many U.S. manufacturers are keen to exploit its potential, claiming that they have the upper hand in customer service and proximity to the market. Key Tronic's Mertens insists that his company is "very aggressive in moving into the standard market." With facilities in Ireland and Taiwan, and headquarters in Spokane, Washington, Mertens claims Key Tronic can service the standard market better than most by offering competitively priced units with the added advantage of being an "onshore" producer.

As the keyboard becomes more of a standard "peripheral" component for the personal computer, new ways are being developed to get the plug-compatible product to market. While OEM sales still account for the lion's share of business, sales-to value-added resellers, systems integrators and distributors are starting to catch on. Both Key Tronic and Maxi Switch and are actively exploring these avenues. Key Tronic sells to regional retail distributors, VARs and systems integrators and is looking to grow in these markets, says Mertens.

Hasan at Maxi Switch admits that Japanese standard keyboard producers, like Fujitsu Ltd., are very aggressive, but he also believes that the exchange rate is really beginning to hurt them. Furthermore, they are disadvantaged by distance, he says. "We offer what no other Far East supplier can: service and point of sale in the U.S." Hasan claims Maxi Switch was the first to come out with a cloned IBM 101-key keyboard. The company sells to OEM clone makers and into the VAR market, which is still growing, he says. □

DATABASE

Recovery pause

New orders for computers and office machinery took a bit of a tumble in August. After rising a revised 12.1% on a seasonally adjusted basis from June to July, new orders dropped 6.7% in August to stand at $4.8 billion. This is the first monthly decline since the 21% drop in January. The computer market was not alone as most major industries experienced decreases in new orders. On a year-to-date basis, new orders for computers and office equipment were up 4.5% from the same eight-month period last year. Backlogs also had a mild setback in August after rising steadily since February. However, at $19.2 billion, they are at their second-highest level since the end of 1985.

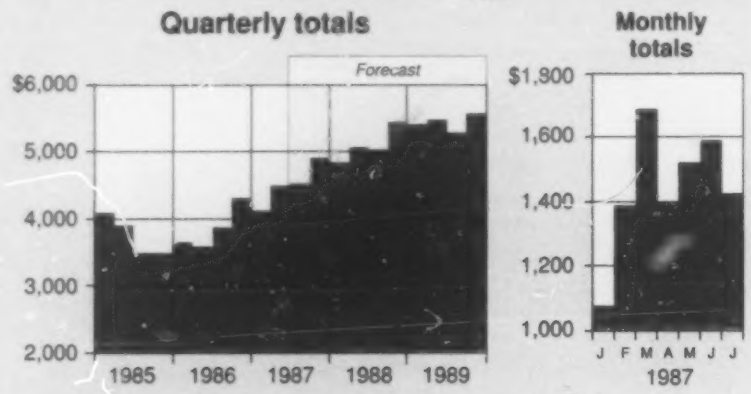
On the positive side, shipments were up just over a tenth of a percent in August, and that was on top of a 5.9% rise in July. Imports outpaced exports for the third time since the start of the year. Exports of $1.4 billion represented a drop of 10.4% from June, while imports increased 1.7% to $1.6 billion. Prices of foreign goods are generally more expensive because of the dollar's depreciation, so a rise in imports on a dollar basis was not unusual. The strong U.S. economy is keeping demand for foreign goods high. On a cumulative basis through July, this industry had a trade surplus of just $49 million.

Edited by LINDA STALLMANN

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158. Phone: (617) 964-3030.

Computer exports

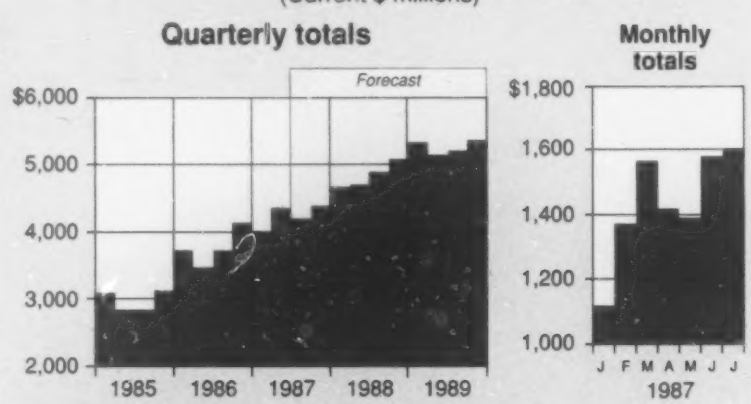
(Current $ millions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer imports

(Current $ millions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA, 1977=100, July)	270.4	275.2	-1.7%	257.4	+5.1%	318.7	+17.9%
Shipments (SA, $ millions, August)	$4,899	$4,892	+0.1%	$4,737	+3.4%	$5,884	+20.1%
New orders (SA, $ millions, August)	$4,837	$5,183	-6.7%	$5,173	-6.5%	$5,506	+13.8%
Unfilled orders (SA, $ millions, August)	$19,214	$19,276	-0.3%	$18,631	+3.1%	$21,505	+11.9%
Inventory-to-shipment ratio (SA, August)	1.97	1.96	—	2.23	—	2.01	—
All employees (thousands, August)	456.6	456.6	+0.0%	475.3	+4.1%	495.53	+8.5%
Production workers (thousands, August)	150.8	148.8	-1.3%	161.8	-7.3%	164.29	+8.9%
Exports ($ millions, July)	$1,422	$1,587	-10.4%	$1,231	+15.5%	$1,683	+18.4%
Imports ($ millions, July)	$1,600	$1,574	+1.7%	$1,400	+14.3%	$1,645	+2.8%

SA = seasonally adjusted, all other data is not seasonally adjusted

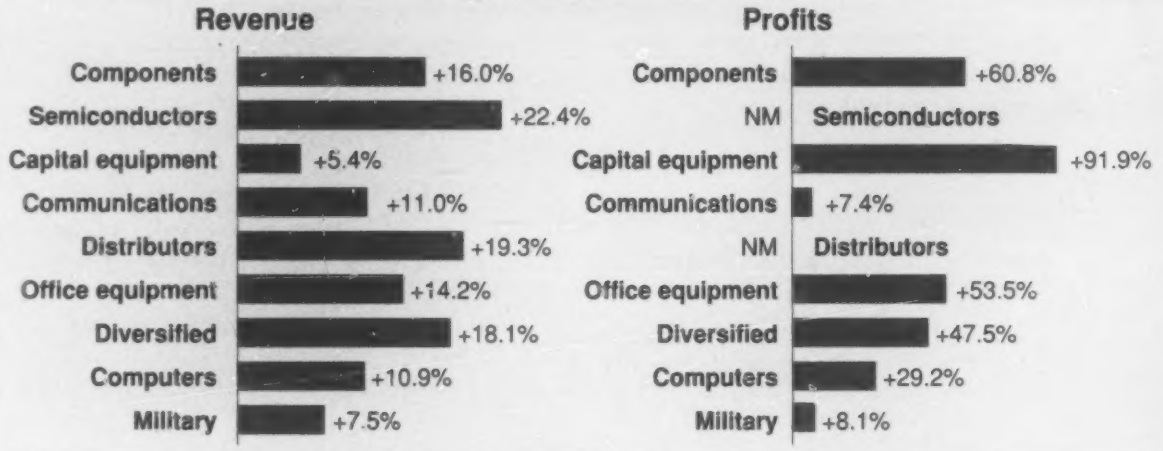
Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 3rd quarter of 1986 to 3rd quarter of 1987



	3rd quarter figures				Year-to-date figures				
Components (other than semiconductors)	Revenue 3rd quarter 1987 ($ millions)	Change from 1986	Profits 3rd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
AMP	$572.7	19.0%	$62.8	49.1%	$1,684.5	18.1%	$179.4	52.0%	Sept. 30
AVX	70.4	49.0%	3.9	802.1%	192.1	32.6%	11.2	NM	Sept. 30
Augat	78.8	18.5%	1.8	-25.5%	232.3	18.6%	8.2	16.7%	Sept. 27
BRIntec	79.7	0.5%	1.9	-26.7%	246.6	3.5%	5.6	-48.5%	Sept. 30
CTS	62.8	1.2%	3.5	770.8%	190.3	5.7%	7.1	NM	Sept. 27
Kollmorgen	70.6	-3.5%	1.3	NM	217.0	-12.6%	-1.1	NM	Sept. 30
Molex	112.2	20.7%	12.8	18.5%	314.2	21.9%	35.9	22.3%	Sept. 30
Segment composite	**$1,047.1**	**16.0%**	**$86.0**	**60.8%**	**$3,076.9**	**14.3%**	**$246.5**	**58.8%**	
Semiconductors									
Advanced Micro Devices [1]	$260.9	13.9%	-$53.8	NM	$734.5	16.4%	-$45.4	NM	Sept. 27
Intel	501.1	54.6%	80.5	NM	1,334.6	46.8%	152.5	NM	Sept. 27
International Rectifier	37.8	-0.3%	-2.9	NM	113.1	0.0%	-3.4	NM	Sept. 30
LSI Logic	68.9	48.0%	3.2	NM	183.9	31.5%	5.6	159.7%	Sept. 30
Texas Instruments	1,416.3	13.4%	69.1	393.6%	4,059.8	11.6%	214.8	1,515.0%	Sept. 30
Western Digital	140.1	48.0%	12.0	60.9%	402.4	55.3%	36.2	65.6%	Sept. 26
Segment composite	**$2,425.1**	**22.4%**	**$108.2**	**NM**	**$6,828.4**	**20.0%**	**$360.2**	**NM**	
Capital equipment									
Computervision	$132.3	5.1%	$1.5	29.4%	$408.7	14.1%	$11.4	NM	Sept. 30
Tektronix	299.5	-1.8%	1.8	-88.0%	1,070.3	3.7%	20.9	-44.7%	Aug. 22
Teradyne	83.1	0.1%	-0.2	NM	241.2	3.7%	-7.0	NM	Sept. 30
Varian	276.0	16.8%	5.3	NM	768.0	13.2%	13.5	NM	Oct. 2
Segment composite	**$790.9**	**5.4%**	**$8.3**	**91.9%**	**$2,488.1**	**8.1%**	**$38.8**	**225.7%**	
Communications									
Avantek	$45.6	1.8%	$1.6	-43.2%	$148.7	8.2%	$9.9	1.5%	Sept. 12
Aydin	37.1	16.1%	1.9	13.2%	107.8	5.3%	6.2	15.1%	Sept. 30
DSC Communications	78.8	11.3%	4.2	41.8%	232.8	1.4%	9.5	9.3%	Sept. 30
Dynatech	88.1	14.4%	5.7	-10.9%	252.4	16.4%	15.0	-17.1%	Sept. 30
General DataComm	45.6	-1.5%	-3.1	NM	148.3	8.3%	-0.6	NM	Sept. 30
Northern Telecom	1,158.1	12.2%	69.5	5.3%	3,554.4	15.8%	207.2	14.5%	Sept. 30
TIE/communications	67.8	0.8%	-0.7	NM	191.1	-18.4%	-4.8	NM	Sept. 30
Segment composite	**$1,521.2**	**11.0%**	**$79.0**	**7.4%**	**$4,635.5**	**12.3%**	**$242.3**	**14.3%**	

[1] Includes Monolithic Memories Inc. since August 13, 1987 acquisition

NM = Not meaningful; company had a loss in the base year

(Continued)

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

	3rd quarter figures				Year-to-date figures				
Distributors	Revenue 3rd quarter 1987 ($ millions)	Change from 1986	Profits 3rd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
Anthem Electronics	$48.7	36.0%	$1.3	74.6%	$140.0	52.2%	$3.1	30.1%	Sept. 30
Arrow Electronics	156.9	22.9%	3.4	NM	451.6	13.7%	7.4	NM	Sept. 30
Avnet	441.1	21.5%	12.2	103.3%	1,241.4	12.8%	24.4	67.1%	Oct. 2
Ducommun	115.7	4.1%	-2.5	NM	339.4	-2.4%	4.7	NM	Sept. 30
Pioneer-Standard	60.5	15.8%	1.3	314.4%	175.5	14.0%	3.1	503.7%	Sept. 30
Segment composite	**$822.8**	**19.3%**	**$15.6**	**NM**	**$2,347.9**	**12.3%**	**$42.6**	**NM**	
Office equipment									
Diebold	$109.3	8.9%	$9.2	26.8%	$319.5	5.2%	$23.8	-4.4%	Sept. 30
NCR	1,339.5	13.8%	97.8	33.3%	3,820.6	15.5%	257.9	27.4%	Sept. 30
Pitney Bowes	550.5	11.1%	46.0	18.2%	1,607.1	12.9%	131.5	17.3%	Sept. 30
Savin	88.8	-1.6%	-3.0	NM	265.0	-5.4%	-1.0	NM	Sept. 30
Wang	693.0	15.9%	22.5	NM	2,262.9	13.1%	60.4	NM	Sept. 30
Xerox	3,800.0	15.2%	134.0	19.6%	10,700.0	16.3%	423.0	12.2%	Sept. 30
Segment composite	**$6,581.1**	**14.2%**	**$306.5**	**53.5%**	**$18,975.2**	**14.9%**	**$895.8**	**28.2%**	
Diversified									
General Instrument	$284.9	71.3%	$15.0	361.5%	$805.9	67.3%	$33.8	187.6%	Aug. 30
Gould	230.4	1.3%	4.8	11.6%	690.5	1.3%	16.3	-44.0%	Sept. 30
Harris	506.6	7.9%	19.9	22.5%	1,721.9	10.1%	68.0	40.4%	Oct. 2
Honeywell	1,636.7	27.5%	69.6	130.5%	4,694.2	24.8%	167.6	51.8%	Sept. 27
Motorola	1,672.0	16.8%	70.0	125.8%	4,857.0	13.8%	206.0	57.3%	Sept. 30
N.A. Philips	1,226.9	13.2%	2.8	-83.9%	3,398.5	7.0%	22.4	7.2%	Sept. 27
Tandy	838.2	12.9%	64.3	47.0%	2,351.8	10.6%	159.0	41.2%	Sept. 30
Zenith	591.8	15.2%	-25.1	NM	1,677.1	29.5%	-23.8	NM	Sept. 30
Segment composite	**$6,987.6**	**18.1%**	**$221.2**	**47.5%**	**$20,197.0**	**16.4%**	**$649.4**	**43.1%**	
Computers, peripherals and software									
Amdahl	$362.7	64.9%	$36.8	417.3%	$1,022.2	62.4%	$93.0	660.0%	Sept. 25
Apollo	135.0	34.5%	-2.9	NM	390.7	44.3%	11.2	175.6%	Oct. 3
Apple	786.4	54.0%	71.7	117.9%	1,998.8	46.1%	159.0	63.9%	Sept. 25
Control Data	831.4	1.6%	6.7	NM	2,439.0	-0.2%	7.5	NM	Sept. 30
Compaq	313.5	112.9%	36.4	318.6%	791.9	80.7%	87.3	227.3%	Sept. 30
Cray Research	184.6	35.2%	36.1	38.3%	523.7	14.2%	113.0	11.3%	Sept. 30
Data General	332.3	0.7%	3.4	-26.1%	961.1	-1.3%	-86.1	NM	Sept. 26
Digital Equipment	2,529.8	24.1%	269.9	47.8%	7,608.9	23.9%	954.7	61.4%	Sept. 26
Genicom	72.9	85.4%	2.0	-12.6%	214.4	87.5%	7.2	18.5%	Sept. 30
IBM	12,727.0	6.9%	1,208.0	12.2%	36,206.0	5.5%	3,171.0	-6.7%	Sept. 30
Intergraph	157.1	4.1%	18.4	18.6%	445.8	-0.6%	45.1	-11.2%	Sept. 30
Lotus Development	101.2	54.4%	19.1	100.8%	280.0	39.3%	49.1	50.1%	Sept. 30
Mentor Graphics	56.0	24.3%	5.3	82.8%	160.4	29.1%	14.2	100.8%	Sept. 26
Micropolis	75.2	35.7%	7.0	43.0%	207.9	28.9%	20.1	53.0%	Sept. 25
Microsoft	102.6	53.7%	21.3	34.3%	300.8	67.8%	57.6	51.8%	Sept. 30
Miniscribe	103.8	116.7%	8.4	38.5%	246.3	86.6%	22.1	35.1%	Sept. 27
Prime	236.2	6.5%	15.9	31.5%	693.9	10.3%	43.5	32.7%	Sept. 30
Seagate Technology	226.1	19.6%	14.8	-39.5%	743.2	62.4%	92.4	75.4%	Sept. 30
Storage Technology	185.9	4.1%	1.4	-71.8%	541.8	5.9%	8.7	-40.1%	Sept. 30
Stratus Computer	48.8	52.0%	5.3	51.1%	129.0	44.6%	12.9	30.8%	Sept. 27
Sun Microsystems	191.7	108.5%	12.9	93.2%	519.3	129.6%	34.0	118.2%	Sept. 25
Unisys [1]	2,223.2	-8.2%	129.7	145.2%	6,914.0	41.2%	361.1	148.9%	Sept. 30
Segment composite	**$21,983.4**	**10.9%**	**$1,927.8**	**29.2%**	**$63,339.1**	**14.7%**	**$5,278.5**	**14.0%**	
Military									
E-Systems	$302.9	26.8%	$15.8	-3.8%	$911.7	9.3%	$42.7	-8.5%	Sept. 30
GM Hughes	2,517.2	-1.2%	171.2	4.6%	7,824.6	-0.5%	524.4	7.6%	Sept. 30
Logicon	53.1	2.8%	2.5	13.6%	154.8	-0.4%	4.1	-42.6%	Sept. 30
Loral [2]	336.9	113.9%	17.3	34.7%	654.7	111.1%	33.0	25.8%	Sept. 30
Raytheon	1,855.0	8.2%	114.6	12.9%	5,523.0	4.9%	327.2	11.4%	Sept. 27
Singer	467.7	7.9%	18.2	4.6%	1,339.3	8.9%	12.8	-55.1%	Sept. 30
Watkins-Johnson	66.1	4.6%	4.5	3.4%	194.6	2.0%	12.9	-5.4%	Sept. 30
Segment composite	**$5,598.8**	**7.5%**	**$344.1**	**8.1%**	**$16,602.7**	**4.8%**	**$957.1**	**6.0%**	

[1] Last year's results only include Sperry for all of September

[2] 1987 results include Goodyear Aerospace Corp., (acquired on March 13, 1987) now called Loral Systems Group

NM = Not meaningful; company had a loss in the base year

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Electronic Business®

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Electronic Business

VOL. 14, NO. 1 JANUARY 1, 1988

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES

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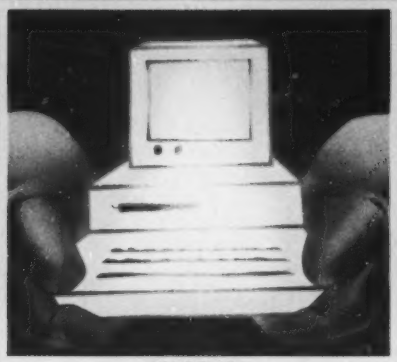

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VBPA ABP

You shouldn't feel down with the Jones' Dow

If you do, you'll miss a good 1988, not to mention the advantages of a competitive dollar

Don't blame the stock market crash, which didn't happen until the fourth quarter of last year. Revenue had already moved onto a slower track during the third quarter for electronics companies in the United States. This past quarter wasn't too bad — revenues were ahead of the year-earlier quarter by 10%. But they undershot by a bit the level that, based on how well 1987 was going in the first half, Cahners Economics had forecast for the second. Same with profits. Instead of besting the third quarter of 1986 by almost 50%, the ELECTRONIC BUSINESS profits index was ahead by 37%.

Based on the not as good as expected third quarter, Cahners has reduced its estimate for revenue growth from 10% down to 8% in 1987, and has shaved a bit from its forecast for profits from a growth of 27% down to a still-substantial 25%. Similarly, but based on his model of U.S. production of electronic equipment, market researcher Ed Henderson estimated that U.S. production in 1987 grew by 6% over 1986, instead of the 7% he had forecast a quarter earlier.

The sample of 16 companies, whose financial results we use to compile the indexes, suggests that the third quarter's underperformance can be traced to two main reasons: weakness in military sales and IBM's slow recovery.

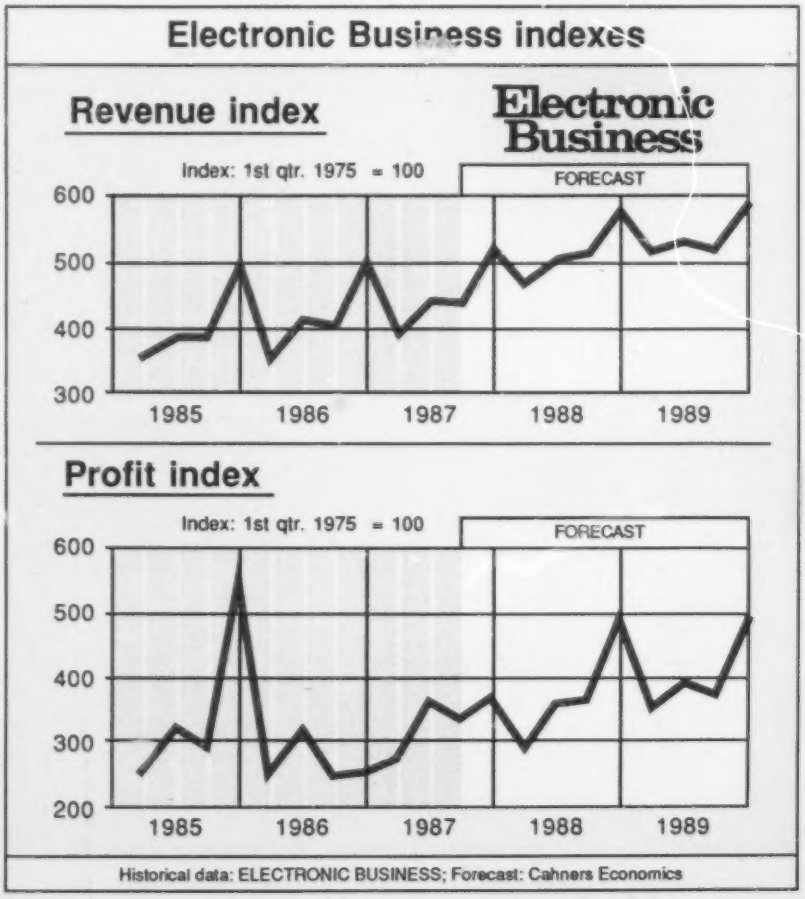
Some military programs are beginning to feel the impact of budget cuts. Even though the increasing electronics content of military systems is expected to offset those cuts, they cannot provide enough dollars to keep the growth at last year's rate. As for IBM, this company's revenue and profits represent a large portion of our index. Big Blue did not fare too badly in outright sales of equipment and did very well in sales of software, but declining maintenance and rental revenue held its third-quarter 7% above last year's.

Had the dollar remained at the same level as last year, however, IBM's revenue would have been lower. As 1987 came to an end, the company estimated that the cheap dollar added approximately 6% to revenue and 26% to profits.

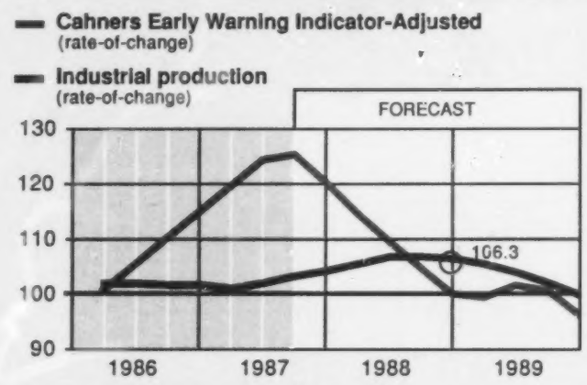
A competitive dollar can work for other companies, too. At the Producktronica Show in Munich, the largest show in the world devoted to production equipment for the electronics industry, European makers of such equipment were feeling the increasing competitive pressure from U.S. companies such as the Dynapert division of Emhart Corp. and Universal Instruments Corp., two leading U.S. manufacturers of equipment used to mount components onto printed circuit boards. The dollar not only helps their export revenue, but also their domestic sales.

The dollar, combined with a still-growing economy this year, will help in pushing the growth of our index for revenue to the 15% growth that Cahners forecasts for 1988, and 13% growth in profits. Henderson puts the growth in production for 1988 at 11%, the highest in recent years. Both forecasters see slower growth in the economy by 1989, and this is what the market drop is telling us.

ALBERTO SOCOLOVSKY



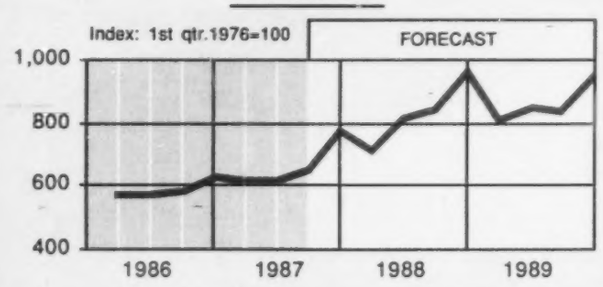
Economic indicators



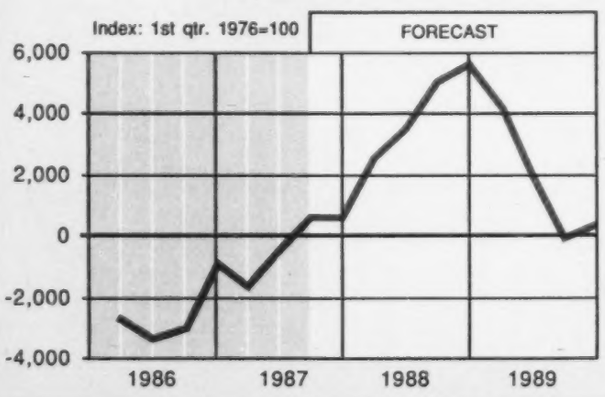
Historical data: Federal Reserve Board; Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. During 1987's third quarter, output rose 2.1% from the prior quarter and was up 3.1% from the same date of the previous year. This slow and steady growth is expected to continue until this summer. Production is expected to rebound after a year and a half of sluggish growth, pushing production up 6.3% this year. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar, inventory replenishment and growth in business equipment investment.

The Cahners Early Warning Indicator (CEWI) has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. The CEWI is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2), deflated by the Consumer Price Index. The CEWI has proven to be an excellent tool in forecasting the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That change over a 12-month period can be determined by comparison with the line at 100. For example, the 106.3 level forecast using the CEWI for the end of this year indicates that the average for all of 1988 should be 6.3% above 1987.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

ATE revenue and profit

The 1987 third quarter revenue for manufacturers of automatic test equipment rose 4.5% above the prior quarter and increased by an even stronger 11.3% over the year-ago quarter. A strong final quarter is expected to raise annual revenue by 13.2%. This year, the demand from computer and semiconductor manufacturers for automatic test equipment shows further signs of strengthening. Revenue is expected to rise a sharp 24.0% this year, followed by a much slower 3.0% increase in 1989.

ATE manufacturers returned to profitability during the third quarter of 1987. Not since the second quarter of 1985 has the ATE index shown positive earnings. Profits are expected to show healthy increases for the rest of 1987, through 1988, with a slowdown forecast in mid-1989.

APPLIANCES

Domestic help wanted: Electronic applicants welcome

If electronics parts suppliers can get prices down, they'll find a huge market in household appliances

The major appliances industry represents an already-large market for electronic components; already in use are membrane touch pads, microprocessors, timers and sensors. But it is a market whose potential has hardly been scratched. Observers see opportunities for everything from smart power chips to brushless motor controllers, and conservative estimates indicate that the business quickly could be worth hundreds of millions of dollars.

Most appliance executives express little doubt about the inevitability of electronic controls for their refrigerators, dishwashers, ranges, washers and dryers. The only question is how quickly such controls will penetrate to lower-priced models. Today, electronic features are exclusively at the high end of the product line.

Currently, best estimates are that between 1.5 million and 3 million major appliances use some type of electronic controls, but that number represents only 5% to 10% of the appliances soid last year. The Association of Home Appliance Manufacturers (AHAM), the industry's Chicago-based trade group, puts total factory shipments of conventional major appliances, excluding microwave ovens, at approximately 32.63 million units in 1986. HAM's figures do not include sales by General Electric Co., Somerville, N.J., the largest appliance manufacturer, which is not a member.) AHAM is predicting relatively flat major appliance sales for the next two years: 33.26 million units for 1987 and 33.03 million for 1988.

However, an AHAM spokesperson notes that the growth is "definitely" at the higher end, which now accounts for about 10% of total purchases and is growing toward 20%. The spokesperson adds: "Remember that 70% of appliance sales are replacements, and those are almost always a trade-up purchase." Manufacturer dollar sales of conventional appliances for 1986 totaled $8.83 billion, according to AHAM.

The use of electronics "has expanded quickly in the top-end products over the last couple of years," notes Douglas Ringger, manager of Maytag Corp.'s product test laboratory. "Appliances are fairly price-sensitive, however, so how quickly that reaches lower levels depends on the cost of components and consumer demand."

The introductions are being made cautiously. Kish Gursahaney, vice president for product development at White Consolidated Industries in Columbus, Ohio says: "No one is out to leapfrog the industry on this. Not when the consumer reaction to these appliances is: 'Explain to me why I need this.' "

"Eventually, all appliances will have advanced controls on them," states Robert Bowen, director of the new products center for Raytheon Co. Raytheon owns the Amana, Caloric, Magic Chef, Speed Queen and Modern Maid appliance lines.

"I think we will be seeing dramatic increases — barring a major change in the economy," Bowen continues. "If we revert back to tougher times, the high end will suffer. It will be hard to beat a mechanical switch that sells for $1.16. But right now the real opportunities are at the higher end," he says.

"Once you get electronics into a product that is not traditionally electronically based, the potential is immense"

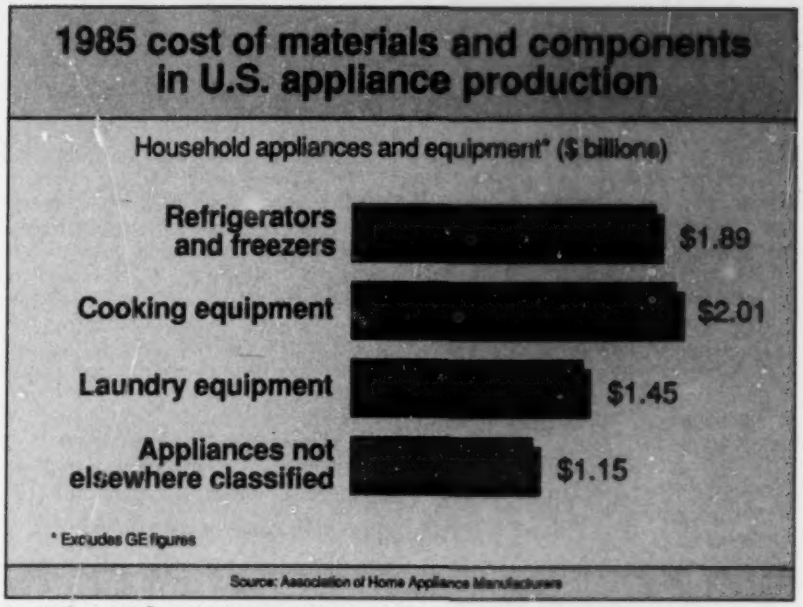
Daniel Artusi of Motorola

Julia Talcott

Change is coming

An executive on the supplier side argues the change is coming. "I've been involved with the appliance industry for over 10 years, and every year I think the time has come for electronics. But so far, it hasn't happened," says Daniel Artusi, director of marketing on power transistors, TMOS and SmartMOS products, for Motorola Inc.'s Phoenix, Arizona-based discrete and special technologies group. "But I see some indications now that the appliance industry is beginning to change."

One key change, he notes, is increased acceptance by the people who use those appliances and who shied away from electronic controls in the past. Artusi credits the widespread use of microwave ovens with accli-



In 1985, the U.S. major home appliance industry spent nearly $6.5 billion for components and materials — only 1% to 2% of it in electronics parts

mating users to electronic controls.

Currently, the components being used most frequently in appliances are membrane touch pads and the microprocessors that run them; timers, either programmed or temperature-controlled; temperature sensors and solenoid-operated motors. Estimates of the value of the electronic components in appliances varies. One executive puts it between $25 and $50 in a dishwasher; another says electronic diagnostic components add between $50 and $100 at retail to the price of a refrigerator, a little more to a dishwasher.

While component cost is a key issue, Raytheon's Bowen notes that direct price comparisons between mechanical and electronic controls are difficult. "Mechanical controls are very low-cost but only perform one function. Typically, with electronic controls, you get more functions for the dollar, but the controls cost more."

Similarly, White's Gursahaney says that suppliers should "work on functionality. If [electronic] components perform functions other than the ones mechanical controls do, then there is a justification to use them and a marketing reason to put them in."

Price parity with mechanical controls is almost a mandatory requirement for widespread use of electronics, Gursahaney adds. Describing prices today as more expensive, he says, "If the price was more in the ballpark of mechanical controls, there would be much broader usage." But today, he says: "There is not enough volume to bring the price down or enough incentive to spend the dollars to develop lower-priced controls."

Bowen of Raytheon makes a similar point when describing the limited interest by electronic suppliers in the appliance market to date. "Part of the problem is the appliance manufacturers cut such a tight deal. None of us makes an exorbitant profit. It all comes back to a volume issue," he says.

However, the enormous potential volume in appliances should be enough to make electronics suppliers consider the market, he says. "For example, there should be a lot of compatibility with people in the automobile industry because they already deal with high volumes and low costs. [Raytheon is] looking in all sorts of nonappliance areas for suppliers. I think any maker of components who wants to expand his business base should start exploring applications in appliances. Look at the volume compared to industrial applications," says Bowen.

Cost is key

Supplier executives agree that component cost is a key sticking point in the major appliance industry's conversion to electronics, but a problem that will be overcome.

The price spread now runs as high as two to one for electronic versus electromechanical components, says Stephen Ahrens, director of RCA Corp. standard IC products for GE. "Once we demonstrate we can get the cost down in volume, the appliance companies will do it," he said.

"The way I see it happening," continues Ahrens, "is on a custom basis. We are not working on, for example, an appliance control timer IC. Instead, we are working on custom circuits for specific appliance models. We are not currently in production on any custom ICs for the appliance market, but we will have such programs in production next year. For us, these are multimillion dollar opportunities."

Among the specific areas GE/RCA is working on are timers — "one of the least reliable parts in dishwashers and dryers," claims Ahrens — and water-level sensors for washing machines.

Daniel Artusi of Motorola agrees with the assessment of the appliance industry's potential as a market. "Once you get electronics into a product not traditionally electronically based, the potential is immense."

He feels the component cost will go down and available functions will increase, with the most widely used components likely to be microprocessors — one or two per appliance — and power devices, particularly power MOSFETs.

Several recent technological advances have appliance applications, Artusi feels. These include electrically erasable programmable read-only memory (EEPROMs), which will remain intact in a power failure without

Although the major appliances market will remain relatively flat in the next two years, it represents a wide-open opportunity for electronics parts suppliers. Less than 10% of the appliances sold last year used electronic controls

requiring a battery backup; discrete power MOSFETs to control the power supplied to motors; and smart power or power ICs to handle small motors such as the solenoids which lock doors, even though the main motors remain too powerful to control with a single IC.

Bob Benzer, new product planning manager for Motorola's bipolar analog IC division, sees near-future appliance applications for brushless motor controllers, particularly for such products as washing machines and dishwashers, and perhaps for refrigerator compressors. "Brushless motors provide a very cost-effective and efficient way to reverse motor direction and perhaps eliminate the mechanical transmission," he says.

Best bet

His associate, Jade Alberkrack, a senior staff applications engineer, predicts that the washing machine will be the first on the market with a brushless motor control. Says Alberkrack: "You can replace the transmission and control the agitation speed. And once you get a processor in there, like the top-of-the-line washers now have, it can communicate directly with a brushless motor IC."

Brushless motors, they acknowledge, cost more than the induction motors currently used in North American appliances. However, they add, brushless motors provide better speed control, and would make appliances compatible with power sources in European and Asian markets.

Several appliance and supplier executives draw analogies between the appliance and automobile businesses regarding the conversion to electronically featured products.

Both industries are fairly concentrated. The major appliances industry has about 20 well-known brand names but only five large producers, the result of a wave of mergers and acquisitions in recent years. The top two companies, General Electric and Whirlpool Corp., each sell more than $4 billion in appliances annually. They are followed, in order, by White Consolidated Industries, now owned by AB Electrolux of Sweden; Maytag Corp. and Raytheon.

"Any maker of components who wants to expand should start exploring applications in appliances. Look at the volume"

Robert Bowen of Raytheon

Like the auto makers in the past, the appliance companies have an enormous capital investment in plants geared to electromechanically controlled products. That capitalization is one reason for the very slow introduction of electronic components in appliances, believes Howard Abramowitz, vice president of the electronic business group at El Segundo, California-based International Rectifier Corp.

Motorola's Artusi feels that the automotive analogy may go further, to include the gasoline shortages of the early 1970s. "I think three to four years from now, the utility companies will approach 100% capacity and there will be big pressure to lower the energy levels of all appliances in the home. Electronics can do things like power control," he says. "Electronic controls won't be in over 50% of the appliance volume in the next three to five years unless we see a big push for energy efficiency," Artusi predicts.

Since their demand for electronic components is still relatively small, appliance manufacturers report little difficulty in obtaining supplies to meet their needs. To date, however, many are sticking with traditional suppliers that have moved into the electronics area. And, semiconductor manufacturers say they are working with both appliance companies and their parts suppliers.

Wanted: Willing partners

"Appliances is a very limited market for suppliers now," notes White's Gursahaney. "The problem is finding the partners willing to invest in the future. Most suppliers want a payback now, and it's not there." White, he says, is currently working primarily with the firms which also supply mechanical controls: Robertshaw Controlled Co. and Ranco Inc.

Roper Corp. is a Georgia-based range manufacturer which sells about 75% of its production to Sears under the Kenmore brand. The company has been in the lead in using electronic components — particularly clocks and timers, but also oven controls — and in putting them on midpriced ranges. Roper works with two suppliers on designing the controls it wants: the Semicon division of Robertshaw and Goldstar Instruments in Korea.

Douglas Ringger of Maytag says his firm does its software in-house. "We design the chip and the whole control and then go to a manufacturer. We want to be very involved to control the quality," he says. Maytag's sources are domestic.

NANCY BRUMBACK

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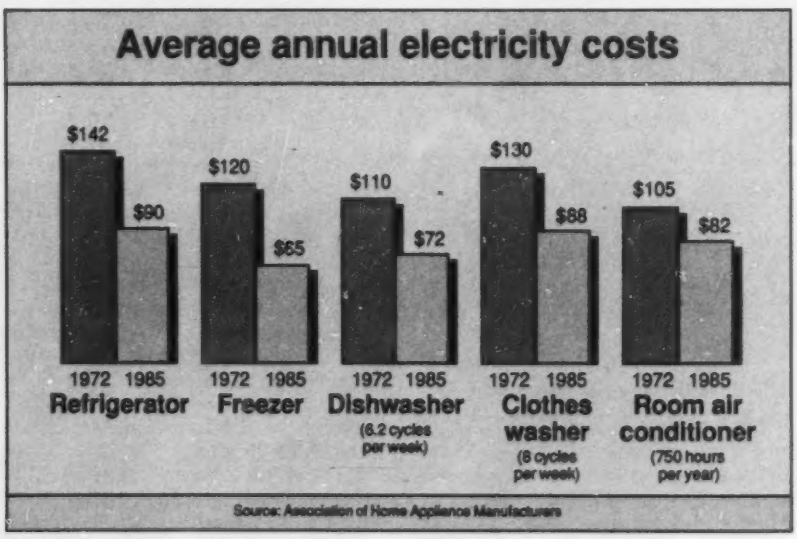


New appliances cost less to operate. Observers believe that electronic controls can help lower their energy usage further to meet predicted power shortages

SEMICONDUCTORS

The ASIC market: Paradise yesterday, war zone today

In 1982, emerging ASIC markets were good to chip start-ups. But now the talk is of shakeout and big-league competition

Service was chic in the semiconductor industry for a long time. The service-based application-specific IC business was considered so highbrow that its players looked down on the commodity market as a Sak's Fifth Avenue store would view competition from a K-Mart.

"Here at last was a Holy Grail semiconductor industry in ASICs," says Xilinx marketing vice president Wes Patterson. "We were seduced into it. The venture capitalists were in a frenzy because now you could sell product that would be priced for its value."

That era is officially over. During the past eight years, over 30% of all semiconductor start-ups formed were in the ASIC business. During the same time, practically every major company announced its intention to enter the application-specific arena, so now everyone seems to be in on the act. A minimum of 100 companies are in the ASIC business, all trying to get a piece of a market valued at $2.8 billion in 1987, according to market research firm Dataquest Inc.

Is that a problem? Indeed. In 1986 just nine ASIC suppliers had 70% of the revenue, according to Technology Research Group, and that percentage is increasing. That still leaves at least 90 suppliers vying for 30% of the market. "There are really only 10 players in the ASIC business," asserts George Wells, president of LSI Logic Corp., one of that elite. "The others are stragglers."

So companies who were there first do not necessarily have the leg up on everyone else. And suddenly the stakes have been raised as falling prices, commodity mentalities and brutal competition mean that the ASIC marketplace is an uptown playground no more.

Not surprisingly, then, the ASIC shakeout has already begun. Almost one dozen small companies have withdrawn from the ASIC market completely, including California Devices Inc., Universal Semiconductor Inc. and Telmos.

The shakeout is likely to continue, as changing market dynamics and economic conditions force small start-ups to either differentiate themselves or face life-threatening price squeezes and competition.

Many start-ups based their business plans around the ability to deliver superior service. Three to four years ago that was a viable idea, but today service is little more than a commodity, or as one wry observer said, the "great equalizer." Every company can offer service, so those offering that but little else are getting left behind in the scramble for market share.

"Service isn't winning designs anymore," says Doug Razer, ASICs strategic marketing manager at Texas Instruments. So, although the ASICs market is predicted to mushroom to $10.2 billion by 1992, the real picture for many companies is not nearly so rosy — or profitable.

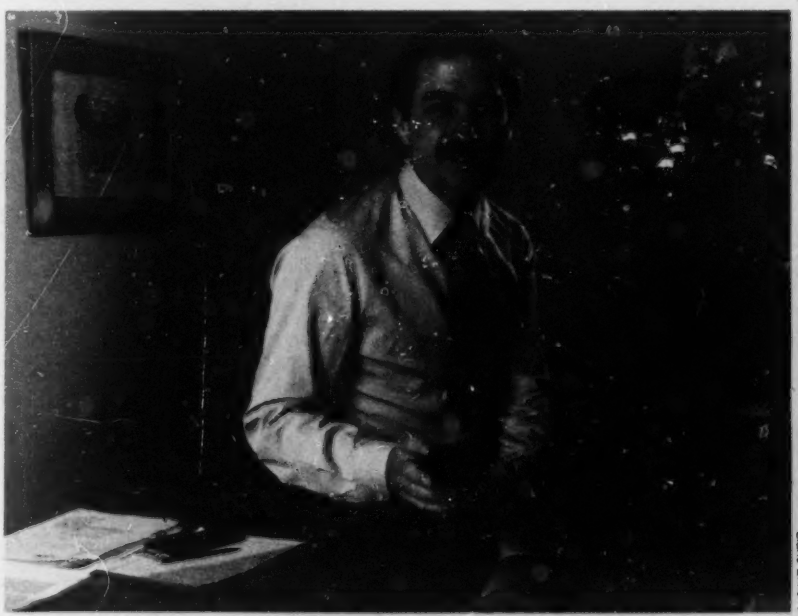
First, and probably foremost, it is difficult to make money in a semicustom business. Customers generally want small numbers of parts, and often need a large amount of handholding, neither of which is inherently profitable.

Fujitsu America Inc., for example, would really like to be a virtual ASIC foundry for its customers, says ASICs marketing manager Gary Hess, because it is difficult to make money on the design and engineering side. At TI, the picture is the same, according to Razer; he says he is trying to get his engineers away from doing simulation and capture for customers so that TI can be more like a design foundry.

But the handholding is not the only reason that companies don't make money in ASICs. Gate arrays, the single largest segment of the ASICs market, are as cutthroat as the memory business ever was, only there are even more players. And like the memory business, the Japanese are a major force in gate arrays, and can afford to apply the price pressure in the hopes of a more long-term market share gain.

Gate array prices have fallen to 0.3 cents per gate, according to Technology Research Group, and the low end of the market — under 10,000 gates — will continue to fall, TRG says.

"It's difficult to make money at the



Liane Enkelis

XILINX'S PATTERSON: "In 1982, the ASICs business was a Garden of Eden"

low end," LSI's Wells says. VLSI Technology, a more recent entry into the gate array market, had lost money on the products until last quarter, says chairman Al Stein. "We are in the black for the first time in this business," Stein says. "It should have a dramatic impact on our profitability."

"If you take away the nonrecurring engineering expenses and sales of the software, it is not a very profitable area to be in," Technology Research Group's Andrew Rappaport contends.

If these large companies are struggling in the gate array market, it is difficult to imagine what smaller companies without deep pockets are doing. And analysts say that the bulk of the smaller players in the ASIC business are in the gate array market — primarily in the low gate count sector.

It is not all gloom at the low end, however. "The low end demand is going to be there," Dataquest Inc. senior analyst Andrew Prophet contends, "but it is a matter of how big a slice of the pie these companies want for themselves."

Only 5% of the market is likely to be at the high end of the gate count at any one time, Rappaport says. But those early adapters tend to outpace the rest of the customer base in density by 25 to 1. In other words, if the top 5% are using 100,000 gate parts, the rest of the industry is probably still at the 4,000 gate level, or not much more.

But will those low-end opportunities be available to small companies that lack their own fab facilities, design software and expertise? Probably not, because large companies have entered the market, and seem to have every intention of remaining for the long term.

The big boys arrive

Although some large companies entered rather late, there are very few reasons to believe that they will not succeed, or that their intentions aren't serious. Motorola Inc., for example, has been a leader in ECL gate arrays for some time, although it has had a slow start in the CMOS area. But companies like Texas Instruments Inc. have reached leadership positions in the standard cell market and are branching out into gate arrays.

As these companies increase their commitment to ASICs, it would appear that the market is ready to buy from them. According to TRG, the size of the typical supplier serving the ASIC market has grown much faster than the industry as a whole each year, meaning that small suppliers are getting squeezed out of the business by larger competitors.

LSI's **WELLS:** "It's difficult to make money at the low end of the ASICs market"

In 1986, just nine ASIC players had 70% of the revenue. That leaves at least 90 suppliers vying for 30% of the market

Yet many of the old-line ASIC players, such as LSI Logic and VLSI Technology, are skeptical of the ability of large companies to make it in a service-oriented, noncommodity business. "The newcomers may look successful," LSI's Wells warns, "but they were doing it to turn their fabs to something worthwhile [during the downturn]. The big guns may move away from ASICs [when times get better]."

"There are a lot of barriers in this market," Stein adds. "I think some [big companies] will abandon the effort, particularly if the semiconductor industry is relatively strong. They have other products that might be more profitable."

But large companies have a vested interest in participating in ASICs. Studies show that customers want proprietary building blocks from which they can leverage their ASIC strategy. Companies like Motorola, Intel and TI, with large percentages of proprietary products, particularly microprocessors and related peripherals, stand to lose a lot if they do not protect their investments.

At Fujitsu, the gate array business is continuing to grow at a rate in excess of 50% over the previous year, and the company is increasing its penetration in the U.S. market, Hess says. Fujitsu is currently going after both the high performance, high-density market, as well as the high volume, low- to medium-density market, Hess says. "It's the 80-20 rule. Twenty percent of the customers have 80% of the consumption. Those people want to deal with someone who is a full-service supplier."

Intel is actually in all three of the ASIC businesses: standard cells, gate arrays and programmable logic devices (PLDs). ASICs general manager Jack Carsten says that Intel is in it for the long term, despite the fact that all three groups only generated $25 million in revenue in 1987. "We're doing it," he says, "but it is painful growing." One area that Intel struggles with is the heavy software requirement in the standard cell arena. Carsten says the company has been forced to do its own software, and that is taking time. The other major challenge has been to change the com-

Liane Sinkelis

pany's attitude about proprietary products.

"In order to be a good ASICs company, you have to have the mindset of working with people," Carsten says. "At Intel we have really viewed our technology as our family jewels, and that to give our secrets away to customers is like selling the family birthright. It is difficult to see how we could make our customers experts without revealing our secrets. We can't, and we've had to change the attitude of the company about that from the top down."

"It's a clear trend," says TI's Razer about ASICs. "Customers want more and need more control." So TI's strategy is to play to this need for control and offer customers standard products with which they are already familiar, such as ASIC products in the digital signal processing area. "Companies who give customers standard products [that] the customer is already familiar with stand a good chance of lasting out in the market."

VLSI is trying to move itself into the next level of gate arrays, with its recently introduced 100,000-gate product. But Wells points out that the company still does a lot of business in the low end, and that manufacturing expertise and streamlining have helped to make the business less of a drag on profitability. "There is really a good business in software right now," he adds, noting that his company has made a name for itself as a top designer of ASIC software and libraries.

"If you have 30 companies in a niche, it isn't a niche anymore," asserts David Angel, a principal in DQ Alliances, a technology alliances firm. The ASIC sector is no different than any other portion of the market right now: small companies must find something they do better than anyone else and then stick to it.

Survival of the smartest

There are several ways to find successful niches however, and some do not even require large amounts of capital investment.

Low-end gate arrays are not a longevity business, but "programmable" gate array vendor Xilinx has probably hit on a solid long-term strategy. Xilinx makes programmable logic arrays (PLAs), which are essentially customer- or user-specific ICs, since the customers do the programming themselves. So what Xilinx has to offer is essentially a custom product (in fact, many argue that PLAs or PLDs are not really ASICs, but the jury is still out) but with all of the flexibility and user configurability necessary to solve the needs of an ASIC world. And Xilinx doesn't need a fab.

Small companies must find something they do better than anyone else and stick to it

"In 1982, the ASICs business was a garden of Eden," Xilinx's Patterson says. "We really believed what we were saying then." But, Patterson says that the young ASIC industry did not really understand the cost implications of a very custom business. "The costs just kill you if you're only building 1,000 or 10,000 parts at one time." But now Xilinx has the solution in the user programmable area, Patterson contends. "User programmable chips will be 30% of the ASICs market by 1990, and the average selling price will be two times higher per gate than standard gate arrays."

Another player, International Microelectronic Products Inc. (IMP), refocused its ASIC strategy to put itself on more sure footing in the long term. When company executives looked around at the market, they saw a need for mixed analog/digital circuits in the ASICs environment. IMP has moved strongly into that niche, has also brought the world of analog design to software for the first time. "In order to make it, you have to be very good at something," strategic marketing director Peter Hillen says. "You have to control your own destiny. We are in a segment of the market that has the highest growth potential."

All-layer custom is the market niche that Sierra Semiconductor has pursued, and according to president James Diller, that is a segment of the market that is strong and getting stronger. "You want to be in an area where you can lead," Diller emphasizes. Sierra also saw the potential of mixed analog/digital and is aggressively pursuing it as well as a number of standard application-specific, very fast memory products.

VALERIE RICE

Estimated worldwide consumption of ASICs

($ millions)

	1987	1988	1989	1990	1991	1992	Compound annual growth
Gate arrays	$2,406.6	$3,163.9	$3,773.6	$4,851.2	$6,175.4	$7,832.2	26.6%
Programmable logic ICs	416.0	582.7	764.0	917.8	1,058.6	1,160.8	22.7%
Total semicustom ICs	**$2,822.6**	**$3,746.6**	**$4,537.6**	**$5,769.0**	**$7,234.0**	**$8,993.0**	**26.1%**
Cell-based ICs	919.4	1,262.7	1,537.6	2,090.7	2,765.8	3,611.3	31.5%
Full-custom ICs	2,283.6	2,395.1	2,204.9	2,148.1	2,115.7	2,087.6	-1.8%
Total custom ICs	**$3,203.0**	**$3,657.8**	**$3,742.5**	**$4,238.8**	**$4,901.5**	**$5,698.9**	**12.2%**
Total application-specific ICs	**$6,026.6**	**$7,404.4**	**$8,2801**	**$10,007.8**	**$12,135.5**	**$14,691.9**	**19.5%**

Source: Dataquest Inc.

VENTURE CAPITAL

The hot new companies of 1988

What makes a start-up hot, and what makes it not? Here's what the venture capital community replied

By Beth Karlin

When the stock market crashed in October, emerging high-technology company executives and venture capitalists held their collective breath. Like most in the financial community, they wondered what would be the long-term impact of Black Monday and the ensuing market chaos. When the dust settled, however, the future of venture capital — and high-tech start-ups — remained promising.

The only real concern was whether today's hot new crop of start-ups will have difficulty going public when the time comes. "The initial public offering market is dead now," Kent Stout, partner in consulting company Deloitte Haskins & Sells' high-technology group in Boston, said shortly after the crash. "If this continues for three or four months, it could be a real problem."

But for emerging companies, that long-range fear was overshadowed by the unbridled enthusiasm often seen in technology pioneers. Flush with the success of gaining investor backing for their products, start-up executives were more interested in the near term. Hoping to repeat the successes of the venture capital-backed stars of the 1970s, the new wave of start-ups stood poised for takeoff.

To find out which firms would likely survive market entry and prosper, ELECTRONIC BUSINESS recently polled about 125 venture capitalists with sizable investments in the electronics industry. In the questionnaire, we asked them to name the most promising start-ups in their portfolios. While our listing on the accompanying pages is by no means complete, the nominees do provide us with a sampling of what many venture capitalists regard as the hot new companies.

In addition, the venture capitalists' responses revealed a broad range of emerging new technologies. Even though products varied widely, most fell into a few general categories:

- **Semiconductors**. Highlighted were BiCMOS products, which combine bipolar and CMOS technologies into one wafer fabrication process; and bipolar VLSI devices.

There may be turmoil on Wall Street but venture capitalists continue to invest in emerging technologies

UPI/Bettmann Newsphotos

- **Minisupercomputers**. High-speed computing for scientific and engineering applications is getting a boost from venture capital investment.
- **Software**. Much of the investment is centered on personal computer software, although the technologies involved run the gamut of applications, everything from design of VLSI devices to software development.
- **Telecommunications**. Local area networks, fiber-optic transmission systems and high-speed modems were frequently cited as fast-track technologies.
- **Imaging systems**. From medical to manufacturing applications, there appears to be ample funding for firms involved in the capture, storage and manipulation of images.

However, while investor interest is strong in these areas, it is not limited to these technologies. Other companies cited in our poll of venture capitalists included Hypres Inc., an Elmsford, N.Y., firm that uses superconductivity for its line of very fast oscilloscopes; and Karlin & Collins Inc., Sunnyvale, Calif., which sells electronic routing systems that give automobile drivers step-by-step directions from one location to another.

And Investment Support Systems, Bloomfield, N.J., has developed software for trading financial futures and options. "This accounting software allows traders to better monitor their positions," says Michael Collins, an investment analyst with TA Associates, a Boston-based

Marty Braun

Venture capitalists handled plenty of hot technology last year. In all, they invested about $3 billion in technology firms in 1987

venture capital firm.

In all, venture capitalists invested about $3 billion in high-, low- and middle-technology firms in 1987, according to *Venture Capital Journal*, up from about $2.9 billion the previous year. When deciding how to invest those funds, venture capitalists evaluate not only the product and the potential market, but the management. Indeed, "the management team is the most important consideration," according to Nissan Boury, managing director of Warburg Pincus Ventures Inc., New York City. "A superb product with poor management usually is no good. But an average product with superb management has a chance."

If our list is any indication, the executive rosters of the new hot companies tend to read like a *Who's Who* of corporate America. Most leave successful firms, lured by a vision of the new American dream — running their own business. Then they have to convince venture capitalists — or other sources of financing — that their vision can become reality. Ultimately, in deciding to fund a company, says TA Associates' Collins: "We just have to believe in their dreams."

A BIT of luck

George Wilson, Kenneth Schlotzhauer and James Picket, for example, all worked together at Tektronix Inc. and cofounded Bipolar Integrated Technology Inc. (BIT), in Beaverton, Ore. Their goal is to convert unbelievers to the advantages of bipolar technology. The company's proprietary "BIT1" process offers high performance at low power. Using the same fabrication techniques as other bipolor and MOS technologies, BIT has achieved VLSI at bipolar emitter-coupled logic speeds.

BIT recently wooed Stephen Cooper away from his job as president and chief operating officer of Silicon Systems Inc. to become chief executive officer and chairman. He replaced Wilson, who continues as president, chief technical officer and member of the board. "Cooper can take us through the transition from the development stage to volume manufacturing," says Les Soltesz, marketing vice president. "We expect to grow to $100 million over the next four or five years," from under $1 million in fiscal 1987, ended in June.

Seed money from Analog Devices Inc. and financing from the likes of BancBoston Ventures, Iterven Partners, Raytheon Co. and Union Venture has amounted to $24.3 million to date. Now BIT is considering going public. But, says Cooper, "current market conditions could affect the timing of that offering."

But BIT is not alone. Many startups are expected to put on hold plans to raise capital in the stock market. Interest in public offerings has dimmed along with confidence in the market. This is both good news and bad news for venture capitalists. The good news is that they will likely do more second-round and later financ-

ing for companies that decide not to go public just yet. And they will make those investments at a time when many companies are undervalued. The bad news is that the market has always represented the big payoff for early investors — the exit vehicle for them to sell off shares and make millions. Now they may have to wait longer. But venture capital has always been a longer term, higher risk investment than other methods of financing.

Take the case of Saratoga Semiconductor Corp., Cupertino, Calif. Last March, the firm raised $17 million in its third round of venture placement, on top of $11.5 million raised in two previous financings. "The enthusiasm among investors was tremendous," says Edward Browder, president. But investors also concur. "Our money speaks better than words," says Gunnar Hurtig, general partner of Weiss, Peck and Greer, a San Francisco venture capital firm. "We were the lead investors in the first and second rounds of financing — and have committed another $3 million in the third round. That should speak highly of our confidence in both Saratoga Semiconductor's business concept and in its management team."

Interest in public offerings has dimmed along with confidence in the stock market

At the core of Saratoga Semiconductor's business concept is BiCMOS, a new process technology that offers the best of both bipolar and CMOS. "Speed and complexity are the two main ingredients required by our customers," says Andrew Wang, chairman and cofounder and previously director of component technology at Amdahl Corp. The company is targeting high-end applications in the military, computer and communications sectors.

"We build the Corvettes of semiconductors," says president Edward Browder, formerly vice president and general manager of the advanced bipolar products division of Fairchild Semiconductor Corp. The cofounders started up Saratoga in late 1985 with the help of 18 employees from Amdahl's failed semiconductor operation — with Amdahl's blessing.

Enticing venture capitalists to invest isn't always easy. Aries Technology Inc. decided the best way to get venture investment was to collect evidence proving that it had developed a product that the market craved. And the best way to do that, says Larry McArthur, president of the Lowell, Mass., firm was to have the customers develop the product in the first place. In Aries' case, the product is its ConceptStation series of mechanical computer-aided engineering software. "It was definitely market-designed product," says McArthur.

Aries spent two years researching potential users, repeatedly visiting 40 *Fortune* 200 companies to find out what engineers wanted. The company hoped to do for mechanical engineering what firms like Daisy Systems Corp. and Mentor Graphics Corp. did for electronics design. "We collected reams and reams of data," says McArthur. So, when venture capitalists asked Aries why it thought it would be successful, he explains, "We could open up our file cabinets and hit them with real-life data. It was amazingly powerful."

As a result, Aries has, since June, raised $24.5 million. And, thanks to a $5 million investment by the Dutch MIP Equity Fund and a $2 million investment by a Japanese company, Aries is moving to Europe and the Far East. Worldwide sales of mechanical computer-aided engineering hardware and software will reach $2.2 billion by 1991, according to Dataquest Inc., a San Jose market research company.

Getting first-round financing

Getting first-round financing can be especially hard, since investors often prefer companies with demonstrated success. Business Software Technology Inc. (BST) waited two years from its start in early 1984 before it went to venture capitalists to finance an acquisition. "By then, we were profitable and management had a proven track record," says John Burton, executive vice president of the Westborough, Mass., firm. Venture capitalists had already begun to notice BST's progress and were ready to invest. "It took us less than 120 days to get the money we needed to buy Condor Technology," he says.

In the beginning, BST founders preferred to make do with profits from consulting services while developing software products to automate change management in the IBM mainframe environment. "We were bootstrapping profitable revenue as consultants to users of database management systems," explains Burton. BST's products enable users of complex and sophisticated information systems to use automation to maintain, document and control systems changes. BST, which had revenue of more than $5 million in 1987, is looking for other acquisitions to expand its product line.

Fiber-optic products

One area that's getting a lot of attention these days is fiber-optic products. With venture capital backing of $2.5 million, for example, Intelco Corp., Acton, Mass., started up in 1985 to design, develop and manufacture state-of-the-art, high-performance test equipment for fiber optic and high-speed digital telecommunications customers. And Licom Inc., Herndon, Va., got venture capital backing to make fiber-optic transmission equipment.

Last February, Licom hired Robert McIntyre as president and chief executive officer. Before joining Licom, McIntyre held the same posts at Siemens Transmission Systems Inc. McIntyre, like many other start-up executives, opted for the challenge and fluidity of an emerging company over the often-staid environment of a large bureaucracy. "I felt the need to work with a company in its growing stage, rather than its contracting stage," McIntyre said when he left Siemens.

Getting first-round financing can be very hard: Investors often prefer firms with demonstrated success

Indeed, it is that desire to make a difference that lures many successful executives away from their secure jobs to high-risk, potentially high-reward opportunities. "It is the new American culture," says TA Associates Collins. "The American dream is no longer just to rise up in a large corporation. The American dream these days is to do your own thing."

On the following pages is our list of this year's promising start-up companies. This is not a conclusive list of U.S. start-ups but a representation of companies that major venture capitalists have endorsed for 1988.

Promising start-ups: A to Z

ELECTRONIC BUSINESS has asked the U.S. venture capital community to nominate the start-up companies which they believe to be the most promising for 1988. We polled over 125 venture capitalists to determine this year's hot new companies. The only other necessary criterion, besides being "hot," was that each nominee should have been incorporated no earlier than Jan. 1, 1984. Each start-up was sent a questionnaire to provide us with additional information on its product and background.

The products range from intelligent pay phones to desktop film recorders. The companies' total equity figures range from less than $1 million to over $30 million. According to the leading venture capitalists, the following 38 companies have demonstrated promising potential for this year.

MARY DONOVAN

Aries Technology Inc.

Larry McArthur
600 Suffolk Street
Lowell, Mass. 01854
Phone: (617) 453-5310
Incorporation date: 11/84
Major financial backers: ABS Ventures Limited Partnership; Alex. Brown & Sons EGA Limited Partnership; Eastech Management Co.; First Capital Corporation of Chicago; PruTech II and PruTech III, funds managed by R&D Funding Corp., a wholly owned subsidiary of the Bache Group; PruTech Project Development Partnership; Citicorp Investment Management; Edelson Technology Partners; Cummins Venture Corp.; MIP Equity Fund
Product: Desktop CAE computer systems
Date available: 6/87
Total equity invested: $22.5 million

ASIX Systems Corp.

Wayne Pittenger
47338 Fremont Boulevard
Fremont, Calif. 94538
Phone: (415) 656-8664
Incorporation date: 10/84
Major financial backers: Paragon Partners, Citicorp Venture Limited, Vista Ventures, Rust Venture L.P., O'Rien Ventures, Republicbank, North Carolina Bank (NCB) Venture L.P., and ECI Ventures (London)
Product: Automatic test systems focused on ASICs for production and design verification
Date available: 9/87
Total equity invested: $8.5 million (second round)

Atherton Technology Inc.

Ram Banin
1333 Bordeaux Drive
Sunnyvale, Calif. 94089
Phone: (408) 734-9822
Incorporation date: 1/86
Major financial backers: Kleiner Perkins Caufield Byers, Mayfield Fund, Menlo Ventures, Morgan Stanley
Product: An integration and portability platform for large engineering projects used to tie together multivendor software tools into one integrated project support environment. The company will also supply specialized tools
Date available: 9/87
Total equity invested: $7 million

BIT - Bipolar Integrated Technology Inc.

George Wilson
1050 N.W. Compton Drive
Beaverton, Ore. 97006
Phone: (503) 629-5490
Incorporation date:
Major financial backers: Analog Devices, Interven Partners, Raytheon Corp., Harvard Management, Banc-Boston
Product: Bipolar VLSI, DSP & technical computing chips
Date available: 9/86
Total equity invested: $24.3 million

Business Software Technology

Nick C. Rini
Westborough Executive Park
114 Turnpike Road
Westborough, Mass. 01581
Phone: (617) 870-1900
Incorporation date: 2/84
Major financial backers: NA
Product: Automated change control for software development
Date available: Early 1987
Total equity invested: NA

Carlyle Systems

Vincent F. Titolo
5750 Hollis Street
Emeryville, Calif. 94608
Phone: (415) 654-2600
Incorporation date: 6/84
Major financial backers: Drexel Burnham Lambert, Union Bank
Product: Turnkey automation systems for libraries and other database management/information retrieval applications
Date available: 6/84
Total equity invested: $3 million

Chromaline Technologies Inc.

Richard B. Tompane
445 South San Antonio Road
Los Altos, Calif. 94002
Phone: (415) 949-5544
Incorporation date: 3/86
Major financial backers: Alpha Part-

ners, Venrock, Arthur Rich, Prince Ventures, Cornerstone Ventures, Apple Computer
Product: 35mm desktop film recorder for making presentation graphics
Date available: Early 1988
Total equity invested: $5 million

Crystal Semiconductor Corp.

James H. Clardy
2028 East St. Elmo Road
Austin, Texas 78744
Phone: (512) 445-7222
Incorporation date: 10/84
Major financial backers: Sevin, Rosen, Bayless, Borovoy; Interwest; Kleiner Perkins Caufield Byers; Berry CASH Southwest Partners
Product: Analog integrated circuits
Date available: 5/86
Total equity invested: $14.7 million

Cydrome Inc.

André Schwager
1589 Centre Pointe Drive
Milpitas, Calif. 95035
Phone: (408) 945-6300
Incorporation date: 5/84
Major financial backers: Aswet Management Co., Institutional Venture, U.S. Venture Partners (seed and first round). Abbingworth Plc, Bryan & Edwards, General Electric Venture Capital Corp., MRI Ventures, Nazem & Co., Oscco Ventures, Prime Computer Inc., Security Pacific Capital Corp., Stanford University Engineering Fund, UNC Ventures, Walden Ventures (second round). N.Y. Life Insurance (third round)
Product: Supercomputer for engineering and scientific, numerical intensive computing
Date available: To be announced
Total equity invested: $32.9 million

Doelz Networks Inc.

A.C. Tedesco
9501 Jeronimo Road
Irvine, Calif. 92718
Phone: (714) 770-1221
Incorporation date: 1/87
Major financial backers: Brentwood, Alex. Brown & Sons, Citicorp, Hambrecht & Quist, J.H. Whitney, Rothschild
Product: A complete data transport network for companies with multiple networks or multiple networking needs and dispersed locations
Date available: 1987
Total equity invested: $32 million

Gamma Technology

Michael Lutz
2452 Embarcadero Way
Palo Alto, Calif. 94303
Phone: (415) 856-7421
Incorporation date: 1/85
Major financial backers: First Analysis Corp.
Product: Facsimile communications for personal computers
Date available: 6/86
Total equity invested: $380,000

Hologic Inc.

Dave Ellenbogen
200 Prospect Street
Waltham, Mass. 02154
Phone: (617) 893-5100
Incorporation date: 10/85
Major financial backers: Burr, Egan, Deleage & Co.
Product: Bone densitometer for osteoporosis screening
Date available: 10/87
Total equity invested: $3.5 million

Intelco Corp.

George Chryssis
8 Craig Road
Acton, Mass. 01720
Phone: (617) 264-4485
Incorporation date: 1/85
Major financial backers: Burr, Egan & Deleage, MCRC
Product: Fiber-optic and high speed digital telecommunication test instruments
Date available: 1/86
Total equity invested: $2.5 million

Microwave Modules and Devices

Joe Johnson
550 Ellis Street
Mountain View, Calif. 94043
Phone: (415) 961-1473
Incorporation date: 4/84
Major financial backers: Bay Partners, Hambrecht & Quist, Grace Venture, Montgomery Ventures, Paine Webber, New Enterprise Associates
Product: High-power RF and microwave amplifiers and amplifier subassemblies for both defense and commerical applications
Date available: 4/84
Total equity invested: $10.7 million

Multiflow Computer Inc.

Donald Eckdahl
175 North Main Street
Branford, Conn. 06405
Phone: (203) 488-6090
Incorporation date: 4/84
Major financial backers: Aeneas Venture Corp.; Harvard Management Co.; Aetna Life and Casualty; Alan Patricof Associates; Alex. Brown & Sons; Bessemer Venture Partners; E.G.C. Limited Partnership; Fairfield Venture Partners; General Electric Venture Capital Corp.; Inco Venture Capital Management; Investech L.P.; John Hancock Venture Capital Management; L.F. Rothschild, Unterberg, Towbin; Morgan, Holland Venture Corp.; Olivetti Partners; Paine Webber Ventures; Regional Financial Enterprises; T. Rowe Price Threshold Funds; Technology Transitions Inc.; Tessler and Cloherty
Product: Minisupercomputers
Date available: 4/87 (another to be announced 1/88)
Total equity invested: $35 million

Natural Intelligence Corp.

Stephen K. Holford
200 Fifth Avenue
Waltham, Mass. 02154
Phone: (617) 890-2440
Incorporation date: 9/85
Major financial backers: Inco Venture Capital
Product: Hardware and software that allow development of Lisp performance signal processing and real-time computing applications using technical workstations and networked computers
Date available: Early 1988
Total equity invested: $1 million

Optigraphics Corp.

James D. Wylie
9339 Carroll Park Drive

San Diego, Calif. 92121
Phone: (619) 292-6060
Incorporation date: 4/84
Major financial backers: Merrill Lynch, BMW, Texaco, National Bank of Paris, Tenneco
Product: Graphics systems to capture, digitize and store images such as original drawings, maps and photos
Date available: 1985; 1986 (two product versions)
Total equity invested: NA

Performance Semiconductor Corp.

Thomas A. Longo
1610 East Weddell Drive
Sunnyvale, Calif. 94089
Phone: (408) 734-8200
Incorporation date: 10/84
Major financial backers: Brentwood Associates, Northwest Fund, VS Ventures, Asset Management, Advanced Technical Venture, DSV, Tayler & Turner, Westinghouse Electric Corp., Harvard Management, IAI, North Star, Seymour Cray
Product: High-end 16- and 32-bit microprocessors. Up to 256K static RAMs. Very fast logic parts
Date available: 1986, 1987 and 3/88
Total equity invested: $32.5 million

Precision Image Corp.

Gary Hughes
501 Chesapeake Drive
Redwood City, Calif. 94063
Phone: (415) 366-8900
Incorporation date: 2/85
Major financial backers: Sequoia Capital, Cross Point Venture Partners, Southern California Ventures
Product: Color electrostatic plotter systems
Date available: 1/87
Total equity invested: $12 million

Ready Systems

(Formerly Hunter & Ready)
Aryeh Finegold
449 Sherman Avenue
Palo Alto, Calif. 94304
Phone: (415) 326-2950
Incorporation date: 1/87
Major financial backers: Adler, Warburg Pincus Ventures, Xerox
Product: Computer-aided real-time design tools for software engineers
Date available: 9/87
Total equity invested: $9 million

Reliability Management Systems

Richard H. Howe
2 Eastwood Road
Windham, N.H. 03087
Phone: (603) 434-2635
Incorporation date: 1986
Major financial backers: Private individuals
Product: Computer software/reliability products for large computer operations
Date available: In 10 to 13 months
Total equity invested: $235,000

Saratoga Semiconductor Corp.

Edward H. Browder
10500 Ridgeview Court
Cupertino, Calif. 95014
Phone: (408) 864-0500
Incorporation date: 9/85
Major financial backers: Weiss Peck & Greer, Matrix Partners, Interwest
Product: High performance semiconductor products made with a BiCMOS process
Date available: 3/87
Total equity invested: $28.5 million

Sierra Semiconductor

James V. Diller
2075 North Capitol Avenue
San Jose, Calif. 95132
Phone: (408) 263-9300
Incorporation date: 1/84
Major financial backers: Arscott; Norton & Associates; Asset Management Associates; Associated Venture Investors; Bay Partners II; Berkeley International; Borg-Warner Electronics; Bryan & Edwards; Burr, Egan & Deleage; Churchill International; Indosuez Investment Management Services; Investors in Industry; Litton Industries Inc.; MIP Equity Fund; Mohr, Davidow Ventures; Sequoia Capital (main investor); Singapore Technology Corp. Pte. Ltd.; Sutter Hill Ventures; Technology Venture Investors-2; Tellabs Inc.; Venrock Associates
Product: CMOS custom and semicustom semiconductor products with complementary ASIC products
Date available: Now
Total equity invested: $44 million - equity; $13 million -debt; $20 million - lease

Silc Technologies

Ralph Linsalata
34 Third Avenue
Burlington, Mass. 01803
Phone: (617) 273-1144
Incorporation date: 2/86
Major financial backers: Adler & Co., Fairfield Venture Partners, Lawrence Associates
Product: Automated VLSI design software
Date available: 1988
Total equity invested: $5 million

Stellar Computer Inc.

J. William Poduska
95 Wells Avenue
Newton, Mass. 02159
Phone: (617) 964-1000
Incorporation date: 12/85
Major financial backers: Greylock Management, Hambrecht & Quist, J.H. Whitney
Product: Very high performance interactive graphics supercomputing workstations
Data available: NA
Total equity invested: $30 million

Supertek Computers

L.W. Mike Fung
2975 Bowers Ave., Suite 203
Santa Clara, Calif. 95051
Phone: (408) 727-5749
Incorporation date: 6/85
Major financial backers: Glenwood Management, Charter Venture Capital
Product: Minisupercomputers
Date available: End of 1988's first quarter
Total equity invested: $2.5 million; $2.8 million (second round)

Syntellect Inc.

S. Thomas Emerson
21200 N. Black Canyon Highway
Phoenix, Ariz. 85027 -
Phone: (602) 264-5900
Incorporation date: 11/84
Major financial backers: Welsh, Carson, Anderson & Stowe; Hambrecht

& Quist Venture Partners; DeMuth, Folger & Terhune; El Dorado Investments; SunVen Partners; Horsley Keogh Associates; Rainier Venture Partners; CIGNA Investments, Advanced Technology Development Fund; Michigan Capital & Service Inc.
Product: An artificial intelligence-based system for automated inquiry and data entry via touch-tone telephones that automates the functions performed by telephone/CRT operators
Date available: 5/86
Total equity invested: $11.8 million

Videotelecom Corp.

Lawrence Seligman
11002-B Metric Boulevard
Austin, Texas 78758
Phone: (512) 834-9734
Incorporation date: 6/85
Major financial backers: Robertson Colman Stephens
Product: Video teleconferencing systems
Date available: 10/86
Total equity invested: NA

Xilinx Inc.

Bernie Vonderschmitt
2069 Hamilton Avenue
San Jose, Calif. 95125
Phone: (408) 559-7778
Incorporation date: 3/84
Major financial backers: Hambrecht & Quist, Kleiner Perkins Caufield Byers, J.H. Whitney
Product: Programmable gate arrays
Date available: 11/85
Total equity invested: $18 million

The following companies were nominated by one of their venture capitalist backers but did not respond to our questionnaire for additional information before deadline:

Aegis Inc.

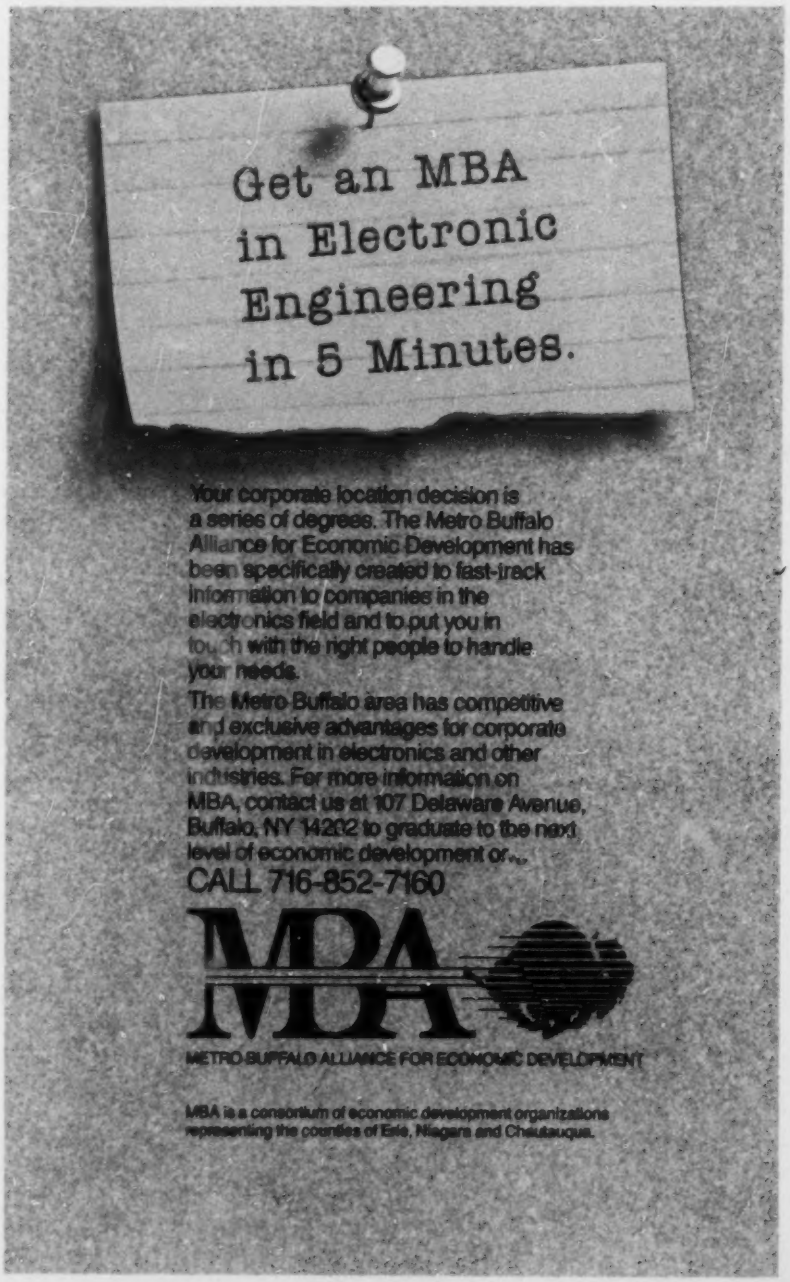
Jay Greenspan
South Welby Road
New Bedford, Mass. 02745
Phone: (617) 998-3141
Incorporation date: 4/84
Product: Packages for microelectronic circuits

Discorp

M. Albert
290 Easy Street, Suite 5
Simi Valley, Calif. 93065
Phone: (805) 584-0688
Incorporation date: 1/85
Product: Document imaging (high resolution) scanning, storage and retrieval using IBM PC AT and PS/2 as a platform

Integrated CMOS Systems

Lin Wu
440 Oakmead Parkway
Sunnyvale, Calif. 94086
Phone: (408) 735-1550
Product: Design and development of application-specific logical systems or subsystems using CMOS gate array technology



Integrated Silicon Systems Inc.

James P. Poitras
P.O. Box 13665
Research Triangle Park, N.C. 27709
Phone: (919) 361-5814
Incorporation date: 4/85
Product: ASIC design and CAE workstations

Intellicall Inc.

Stephen Polley
2155 Chenault, Suite 410
Carrollton, Texas 75006
Phone: (214) 416-0022
Incorporation date: 11/84
Product: Intelligent pay telephones

Karlin & Collins

Barry Karlin
740 East Arques Avenue
Sunnyvale, Calif. 94086
Phone: (408) 736-3700
Incorporation date: 8/85
Product: Electronic navigational aids

Licom Inc.

Robert McIntyre
400 Herndon Parkway, Suite 500
Herndon, Va. 22070
Phone: (703) 689-0500
Incorporation date: 1/84
Product: Fiber-optic communication equipment
Total equity invested: $20.75 million

Molecular Devices Corp.

Gary Steele
3180 Porter Drive
Palo Alto, Calif. 94303
Phone: (415) 493-0166
Incorporation date: 6/84
Product: Silicon-based biomedical instrumentation

Ultron Labs

Wayne Catlett
4423 Fortran Court
San Jose, Calif. 95134
Phone: (408) 945-8812
Incorporation date: 1985
Product: Cryptographic systems

Two publicly held companies, Digital Microwave Inc. and IMProCOM Inc., were also nominated by the venture capitalists that we surveyed, but were not included.

Digital Microwave Inc.

William E. Gibson
170 Orchard Way
San Jose, Calif. 95134
Phone: (408) 943-0777
Incorporation date: 1/84
Product: Short-haul digital microwave radios

IMProCOM Inc.

Fred M. Jenner
6101 Idlewild Road, Suite 326
Charlotte, N.C. 28212
Phone: (704) 535-6574
Incorporation date: 10/85
Product: Image-processing communications

CAHNERS HAS YOU COVERED IN THE WORLD'S LEADING ELECTRONICS MARKETS...

TOKYO, JAPAN JANUARY 20-23, 1988	NEW DELHI, INDIA FEBRUARY 15-17, 1988	ANAHEIM, CALIFORNIA FEBRUARY 23-25, 1988	BIRMINGHAM, ENGLAND MARCH 22-24, 1988
SEOUL, KOREA MARCH 24-26, 1988	BEIJING, CHINA APRIL 19-24, 1988	BOSTON, MASSACHUSETTS JUNE 14-16, 1988	SINGAPORE SEPTEMBER 14-17, 1988
OSAKA, JAPAN SEPTEMBER 21-24, 1988	BIRMINGHAM, ENGLAND SEPTEMBER 27-29, 1988	BRIGHTON, ENGLAND OCTOBER 18-20, 1988	KUALA LUMPUR, MALAYSIA JULY 1989

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Executive summary

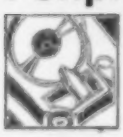
Economic overview PAGE 56

Will the recession hit in 1988, and if it does, in which quarter? The debate rages — despite a series of optimistic forecasts by a variety of market researchers.

Computers PAGE 60

Stable growth is the watchword for 1988. Dataquest projects sales of business computers systems will reach $21.3 billion this year, and the desktop departmental computer market will reach $3.6 billion.

Peripherals PAGE 66



Makers of everything from printers to disk drives find they must keep forcing prices down. 1988 will be no exception.

Semiconductors PAGE 68

The Semiconductor Industry Association remains optimistic about chip demand, despite fallout from "Black Monday." Sales are expected to soar 18% this year, officials claim.

Components PAGE 72

Worldwide demand for surface-mount (SM) capacitors will reach 48.6 billion units by 1990. Demand for SM resistors will reach 50.5 billion units during the same time frame, industry sources say.

CAD/CAM/CAE PAGE 76

If all goes well, U.S. vendors should ship $4.95 billion worth of computer-aided engineering, design and manufacturing systems this year, reports Daratech Inc.

Production equipment PAGE 80

Worldwide sales of semiconductor manufacturing equipment could grow 24% to $7.1 billion this year, according to VLSI Research Inc., as new technologies take hold.

Test & measurement PAGE 82

Prime Data Inc. predicts there will be steady growth in the T&M market in 1988, as worldwide sales hit $8.2 billion by year-end, up 13% over the previous year.

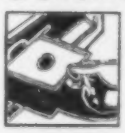
Communications PAGE 84

Developments in transmission equipment will drive the telecommunications market this year — a market that Dataquest says will exceed $203 billion by 1991.

Distribution PAGE 88

The $7 billion industrial distribution market is driven by end-user demand, and that's still a big question mark. But the National Electronic Distributors Association is forecasting 16% growth this year.

Software PAGE 92



Sales of all types of software — including systems, tools and applications — should jump nearly 23% this year, to $24.4 billion, according to Input.

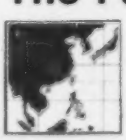
Electronic materials PAGE 95

After three years of flat pricing, silicon prices are strengthening — reflecting stronger demand in 1988, according to Rose Associates.

Europe PAGE 97

Despite recessionary fears, optimism abounds on the Continent, where Dataquest is projecting that European sales of 1Mb DRAMs will reach 20 million units this year.

The Far East PAGE 100



The four tigers — Hong Kong, Singapore, South Korea and Taiwan — today consume $2.9 billion in semiconductors. By 1992, consumption will reach $13 billion, according to Dataquest.

BY BARRY CUSICK

Electronics in '88: Growth, but no cigar

U.S. electronics firms expect upturn despite threats of recession. But wariness is the watchword: 1989 may be grim

Things looked so promising. All the indications were pointing to solid growth in 1988 in most sectors of the electronics industry, with some surprisingly lively upturns in segments like personal computers and — yes — even semiconductors. And as the order books fattened, few saw much reason to fret unduly over what appeared to be the U.S. government's problems alone: the large trade deficit and an alarmingly steep national debt.

But that was before Oct. 19, 1987 — the day the Dow Jones Industrial Average went into free-fall, losing altitude at a rate that not even the most prescient economist might have predicted. And suddenly, all those magazine articles and pop-pyschology books with alarmist titles like *The Great Crash of 1990* — the ones that most had written off as contrarian doom-mongering — had a nation full of riveted readers.

Electronics executives were among the most avid readers. Accustomed though they are to business cycles that make most fairground rides look tame, none was prepared for the Wall Street debacle, and everyone craved insight and guidance to help their forward planning.

Initially, it didn't look as if they were going to get it from any of the usual sources. Economy watchdogs like Analytics, a Palo Alto, California-based consultancy, cut their forecast for 1988 electronics-industry growth in half, from 8% to 4%. Other forecasters held off, pending more news from the financial leaders. And everyone wondered whether the big recession was finally on its way. "If the financial markets affect the economy in the worst way, then all bets are off," says James Burns, president of chip maker Burr-Brown Corp.

Monetary meltdown

The monetary meltdown caused major consternation at one important conference on the semiconductor industry: top-level management like Intel Corp.'s chairman Gordon Moore cut short presentations as they rushed off to become involved in a little crisis management.

The electronics industry will grow at a real 7.2% rate in 1988, while the real GNP overall will grow 5%

The stock shock showed up in other ways, too. For one maker of rigid disks for disk drives, Disk Technology Corp., it was the final straw that poked it into Chapter 11 proceedings after its secondary stock offering failed. And semiconductor production equipment maker GCA Corp. postponed a $22 million equity offering because of the diving Dow. Says Kent Webb, founder of Analytics: "[Shakiness on Wall Street] makes it harder to raise capital through the equity market. It's shaken the confidence of consumers and business people and raised the fundamental problems of the national and the trade deficit."

But by mid-November, some semblance of normalcy was returning, albeit in an environment in which the Dow Jones indicator was running more than 20% lower than its August peak and where the dollar had slid down further than it had previously for many a year. And a degree of optimism had begun to creep back into the conversations of electronics executives. "It's very unclear what impact, if any, these two days [Oct. 19 and 20] will have on calendar 1988. If capital spending is approximately what was forecast, everything will be OK," said August Klein, president of computer maker Masscomp Corp.

Others remained positively upbeat: "I don't see any fundamentals that suggest that 1988 won't be a good year," declared Michael Hackworth, chief executive of chip maker Cirrus Logic Inc. And at the Comdex computer show in Las Vegas in early November, despondency was a much scarcer commodity than buoyancy over the personal computer renaissance.

And those who study the economic tea leaves had begun sounding more cheerful. According to Kenneth McGill, a senior economist with Philadelphia-based Wharton Economic Forecast Associates (WEFA), the electronics industry will grow at a real 7.2% rate in 1988, while the real gross national product (GNP) overall will grow 5%. "The electronics industry is growing one and a half times faster than the rest of the economy. In 1986, electronics comprised 15% of total U.S. manufacturing. In 1988, it should be 16.3% and by

1991, 17.2%," reports McGill.

By mid-November, the appearance of improved trade figures for September had put most observers into a more relaxed frame of mind. As the dust settles, the word from one research firm that polls a broad cross-section of economists — the Arizona-based Blue Chip Economic Indicators — is probably as valid now as it was when it was written nine days before Wall Street's embarrassment: "The consensus says next year will not be an economic paradise — nor will it be an economic hell. It suggests special caution for 1989 and/or 1990. Maybe a recession [and a short one at that] but it won't be the beginning of a depression!" says the report.

Optimism for electronics

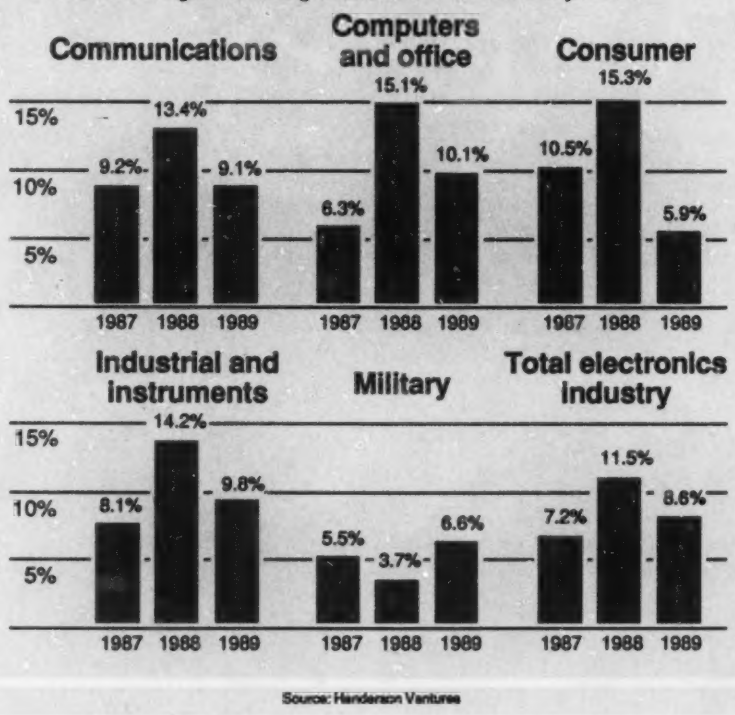
WEFA's McGill cites several factors behind his optimism for electronics, including technological advances, low OEM material and supply inventories, increased long-term equipment investment, a weaker dollar and an improving trade balance. He makes one long-range caveat, however: "The growth in the electronics industry over the next 10 years will be slower than the last 10."

Another forecaster, Data Resources Inc. (DRI) of Lexington, Mass., predicts that investment in electronics will be up across the board in 1988. DRI forecasts that capital investment in office computers and office machines will increase from 1.4% growth in 1987 to 11.4% in '88; investment in electronic computers and accessories will rise from 2.9% to 8.0%; and investment in radio, TV and communication equipment will jump from no growth in '87 to a 7.6% rise this year.

DRI expects the semiconductor market to grow 9.1%, compared to 6.3% in '87. "The industry broke out of its slump in the second quarter of 1987," said senior economist Richard DeKaser. "There's always a lag between computer manufacturing and computer component production."

The low point for the coming year appears to be in the military and aerospace sector. Virtually every analyst agrees that the military will be the weakest sector in electronics in 1988. The military budget, growing at a record peace-time rate under Ronald Reagan, is now being reduced. "Government spending went at a very fast pace in the last five years and things are tapering down," said Ralph Anavy, president of San Francisco researchers Electronic Outlook Corp.

This year should show some recession-beating growth in most electronics segments — but 1989 will wipe the smiles off executives' faces



Source: Henderson Ventures

Analytics' Webb says computer and office machines will make the largest gains. "The unveiling of IBM's new personal computer system has reduced much of the technological uncertainty that dampened the PC market in the recent past," Webb says. "PC demand should receive an additional boost from the replacement market now that the first wave of machines installed in 1983 and 1984 are reaching the end of their useful life."

Edward Henderson, president of Henderson Ventures of Los Altos, Calif., predicts consumer electronics will top the growth market, at a real 9.0%. Henderson thinks the consumer market will be most affected by fluctuating exchange rates. Electronic Outlook's Anavy predicts that the consumer market will be strong next year, mainly because personal disposable income is up.

For all this resilient optimism, however, there remain many nagging worries about where the U.S. economy really is headed. Issues such as the trade imbalance loom large, and the bullish conviction that consumers and capital-equipment buyers will not rein in spending remains untested. For consumer markets, the Christmas merchandising melee will be a crucial gauge. For capital-equipment sectors, the start of new fiscal years will prove interesting.

Crimped capital spending

Indeed, there is evidence to suggest that electronics industry capital spending *will* be crimped: Kenneth Olsen, president of Digital Equipment Corp., recently indicated that DEC was digging in for a possible recession by slowing down hiring and capital spending. Many other electronics companies may use the influential computer giant's actions as their yardsticks, too.

Many take comfort in an apparent silver lining to Wall Street's October cloud: that the stock shock at least awakened the Reagan administration to the severity of the trade and national deficits. The federal government has set its sights on a $23 billion

cut in the national deficit for fiscal 1988, a target many economists argue is not high enough. Meanwhile, the Congress is stepping up efforts to thrash out a more conservative budget. Whipping senators and representatives along is the automatic budget-cutting mechanism that will make indiscrimate across-the-board cuts: the Gramm-Rudman-Hollings law, which was due to go into effect Nov. 20.

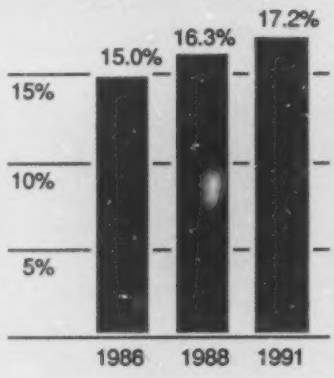
Readings on the health of the general economy remain mixed. Analytics, for instance, predicts 3.4% real GNP growth this year, compared to WEFA's estimate of 5.0%. The average of 51 analysts polled by Blue Chip Economic Indicators calls for real growth of just 2.8%. Some venture capitalists at least hold out hope: Claims Kipling Hagopian, general partner at Brentwood Associates in Los Angeles: "It will be a good year in industry in general because the economy is still strong."

Much depends on how quickly the trade deficit erodes. Henderson says that an improving export rate will create "the economy's longest peacetime expansion on record, into 1989, but we will slide into a recession at the end of 1989." Just as deterioration in August's trade balance pushed panic buttons all over Wall Street in October, the report on September's improved figures — a $1.6 billion drop to $14.1 billion — sent the Dow Jones soaring again. "The real merchandise trade balance will be [a negative] $131.6 billion in 1988, as opposed to $158.6 billion in 1987. It's definitely getting better," says WEFA's McGill.

"Although the situation is far from certain," Henderson says, "it is likely that the trade deficit will not deteriorate further during the next two years, and will probably improve significantly. In real dollars, the trade rate has improved three quarters in a row."

Real dollars are a real issue. Early-1987 declines in the greenback's value appeared, to the surprise of many, to do virtually nothing to boost U.S. exports and stem the tide of imports. But the improving trade balance may be the evidence that economists have been waiting for. Additionally, November's dramatic drop in the value of the dollar may at last jerk imports back into line as overseas business, which until now has been absorbing the higher cost of selling into the United States, is forced to increase prices to maintain some semblance of profits.

Electronics is growing 50% faster than the rest of the economy, increasing as a percentage of America's manufacturing output



Source: Wharton Economic Forecast Associates

Henderson predicts that a weaker dollar will help U.S. exporters soon. "There is usually an 18- to 24-month lag between the decline in the value of a currency on international markets and the start of a trade recovery," he says.

Trade retaliation

However, there is rising concern that Congress, impatient with the bloated trade imbalance, may force through tariffs on imports, a prospect that could easily invite retaliation and alienate the very overseas markets that the United States needs to nurture if its exports are to grow.

A side effect of the dollar's devaluation is that more foreign companies are setting up manufacturing facilities on U.S. soil. Henderson Ventures' Henderson believes the influx of Japanese electronics manufacturers to the United States will continue. "The new rules of the game are that you manufacture where you market," he says.

A related area of uncertainty is the future of America's relationship with Japan. Japan's financial sector has underwritten much of the U.S. expansion, pushing America's debt to Japan to alarming levels. And word is surfacing that consequently, those Far East investors worry over whether America will become "Japan's Brazil." Changing the relationship may involve radical compromises in the future, compelling Japan, for example, to import more from the United States; or to play a wider role in global defense, and forcing the United States to become more of a team player on the economic field.

It also means that America's economic pundits will be watching the way that Japan's new prime minister, Noboru Takeshita, starts to run the country. Which, in turn, raises the question of what effect the new U.S. leader will have when elected this November. Traditionally, the economy gets a pick-me-up in the months prior to the presidential elections, but whether this is enough to stop any economic downdraft, few can say.

However, none of this implies that U.S. electronics executives can put the onus entirely on the federal government. Electronics Outlook's Anavy says that U.S. corporations "need to take a long-term approach which will cost them in the short run, and develop lean volume-production techniques" in order to compete in the global electronics market. "High-tech trade deficits need more than just exchange rate adjustments to be rectified," he says.

Interest rate fluctuation — a traditional worrier — is currently taking a back seat to obsession with the vicissitudes of the Dow. Prior to Wall Street's crash, interest rates were inching northward, a direction that was sharply reversed by the Federal Reserve in response to the stock market disaster and further lubricated by the dollar's slide. New lower rates should ease capital-spending constraints.

One universal belief among experts is that electronics will continue to outperform the economy for the forseeable future. WEFA's figures show the industry created 15% of all manufactured goods in 1986, while its employees made up only 2.5% of the workforce, says Harry Lowenstein, manager of industry statistics for the American Electronics Association of Palo Alto, Calif.

If there is any lesson in the traumatic financial events of late 1987, it is that electronics managers need to prepare better than ever before, by pursuing economic and market outlooks in more detail than ever and by devising worst-case plans that can be implemented at short notice. Given the vagaries of economic life in the late 1980s — and given that 1989 may show sharp slowdown — this is basic survival strategy. □

BY ANNE KNOWLES

Computers: Stable growth is the watchword for 1988

Many manufacturers are sure computer buying will continue. Watch high- and low-end systems markets for the best action

Despite economic uncertainties, many computer manufacturers are fairly optimistic about the year ahead. Although few company executives are game to predict the economy's immediate future, most appear confident that the hardware industry is protected from all but the worst economic disasters.

"If there is a moderate downturn, we are relatively well insulated because people spend money on products to improve productivity," says Jack Lewis, Amdahl Corp.'s chief executive officer. "Demand for our products is very strong and we don't see any change."

Gilbert P. Williamson, executive vice president of NCR Corp., agrees. "We don't see any big warning signs," he says, speaking of a slowdown. "To date, there has been no overt activity by our customers," to curb computer buying, adds Williamson. Instead, the NCR executive believes computer spending will be maintained because users purchase systems to improve efficiency, especially in times of trouble. Says Williamson: "That augurs well for the future, even in view of uncertainties."

Apparently, many industry watchers concur. Revenue for business computer systems, excluding personal computers, is expected to rise 7%, from $19.9 billion in 1987, to $21.3 billion this year, according to Dataquest Inc., a market research firm in San Jose. The highest growth area should be what Dataquest defines as small departmental computers, priced between $25,000 and $75,000. Dataquest estimates that sales of such systems should increase 9%, to $3.6 billion in 1988.

Double-digit growth

Personal computer sales will post double-digit growth, according to Peter Teige, an industry analyst with Dataquest. The worldwide market for microcomputers should jump 10.5% in 1988, to $38.9 billion. Shipments for the year will increase to 18.9 million units, up from 17.1 million personal computers shipped in 1987.

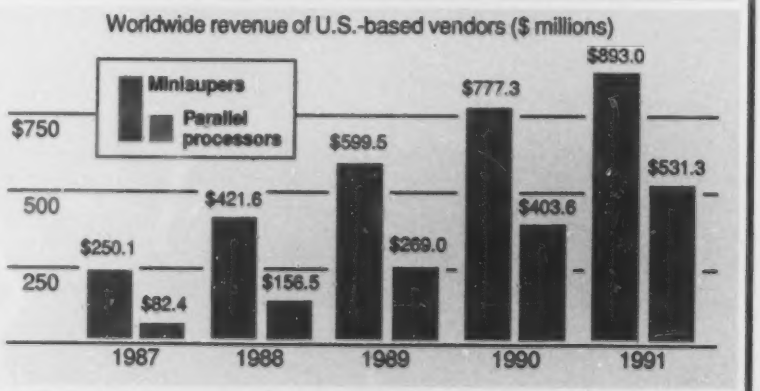
Spurring that momentum will be IBM's projected sales of its new PS/2 models, which incorporate Intel Corp.'s 32-bit microprocessor, the 80386. IBM started shipping the high end of the PS/2 line, the Model 80, in volume this past October. And Big Blue was expecting to set records during that last quarter alone. "IBM is claiming it is going to ship as many 386-based systems as anyone else has all year," says Dataquest's Teige. Teige believes the onslaught of 386-based products — such as IBM's PS/2 models and Compaq Corp.'s Deskpro 386 — will continue this year, pushing sales of such systems to one million units.

The barrage of PS/2 clones may begin in 1988 also. Teige says there is wide-ranging speculation on whether other manufacturers can copy the IBM systems, without catching the wrath of IBM, by the end of this year. Many analysts believe the third party clones won't start parading until 1989. In any case, says Teige, "they may be off the market as soon as they hit the market, if IBM decides to litigate." And taking PS/2-compatible makers to court for copyright violation may be easier to accomplish than expected. Says Teige: "IBM thinks it will be difficult to duplicate the firmware. IBM has ways to test compatible PS/2 machines to see whether clones violate copyrights. They can be easily tested and evidence can be easily obtained."

But the delivery of OS/2 will be the most significant microcomputer event this year. Microsoft Corp.'s operating system designed for the PS/2 line of computers was scheduled to ship to customers last December. IBM should deliver its proprietary graphics interface for the system, called the Presentation Manager, sometime later. By the end of the year, says Teige, IBM should ship its proprietary version of the operating system, called the Extended Version, which has an embedded database management system. A surge of third party application packages written for the new operating system will appear by year-end also.

Apple Computer Inc. hopes to maintain its apparent success selling systems to corporate accounts. Dataquest's Teige thinks Apple will an-

Parallel-processor computers are expected to win greater acceptance in commercial applications



Source: International Data Corp.

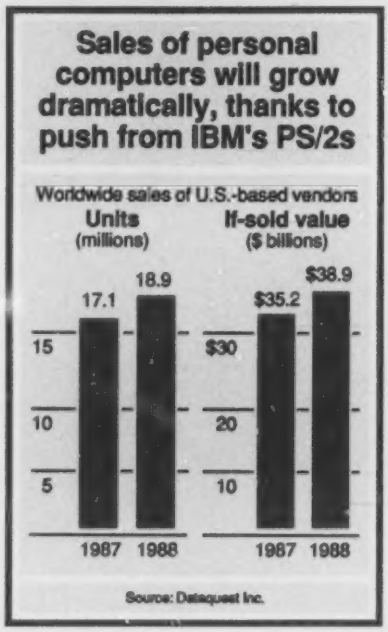
nounce both new additions to its family of microcomputers, and the first round of price reductions on its current models, the Macintosh II and the Macintosh SE.

At the other end of the computing spectrum, the competition is heating up. The supercomputer market has an unprecedented number of players and the premier position held by Cray Research Inc. is being challenged by both domestic manufacturers and Japanese players. In the United States, there are start-ups like CHoPP Computer Corp., which expects to deliver its first supercomputer in late 1988, and Saxpy Computer Corp. In addition, ace designer Steven Chen left Cray last year to found SuperComputer Systems in Eau Claire, Wis. And ETA Systems last year announced a $20 million sale of its eight-processor Model E supercomputer to the Tokyo Institute of Technology.

Japan's market has been difficult for American manufacturers to crack, and it represents up to 40% of the worldwide supercomputer market, says Vicki Brown, an industry analyst at International Data Corp., in Framingham, Mass. The worldwide high performance hardware market, which includes supercomputers, minisupercomputers, parallel processors and high performance mainframes, will hit $2.2 billion this year, up from $1.5 billion last year, according to IDC. The supercomputer segment, says Brown, was $703.8 million last year and is growing 20%, compounded annually.

Lloyd M. Thorndyke, president and chief executive officer of ETA Systems, says the company was able to sell in Japan because the buyer required a system based on multiple processors. To date, the three Japanese supercomputer suppliers — Fujitsu, Hitachi and NEC — do not offer multiprocessor systems. But Thorndyke believes that will soon change. He says that in 1988, "all supercomputer companies will announce some configuration of a multiprocessor system." When ETA's multiprocessor machine won the bid at the Tokyo Institute of Technology, says Thorndyke, "the message got through to the Japanese companies. And they learn fast."

IDC's Brown expects the hottest sales growth to occur in parallel processors. In 1987, sales of multiprocessor-based computers used as parallel processors reached $82.4 million. Brown anticipates that figure will jump to $156.5 million this year and continue to grow 66.8%, compounded annually, over the next five years.



IDC's Brown also thinks parallel processors — which divide pieces of a program among multiple processors — will continue to gain acceptance in commercial applications. For example, BBN Advanced Computers Inc., a subsidiary of Bolt Beranek and Newman Inc., in Cambridge, Mass., announced its RT1000 Butterfly parallel processor, which will incorporate a real-time operating system developed by MTS Systems Corp., for manufacturing applications. Thinking Machines Inc., also in Cambridge, has sold its Connection Machine — using 64,000 processors — to such commercial users as Dow Jones Information Services, for on-line database services, and United Technologies, for computational chemistry.

The supercomputer segment was $703.8 million last year and is growing 20% annually

"A trend in the minisupercomputer market will be the progressive use of these machines outside R&D and into heartland America," says Robert Hesser, vice president for marketing at Cydrome Inc., a minisuper maker in Milpitas, Calif. Frank Vince, vice president for marketing at Convex Computer Corp., a minisuper manufacturer in Richardson, Texas, agrees. "Early innovators have been the universities. We affectionately call them the lunatic fringe," says Vince. "Now we are making inroads into industrial America."

While sales of minisupers should jump to $421.6 million in 1988, up 68.5% from last year, the competition is starting to close in. Last year, ETA Systems announced its ETA10-P, which sells for less than $1 million and is much closer in price to the minisupers than Cray Research's $2 million supercomputer. And Digital Equipment Corp., says IDC's Brown, should announce a vector processing add-on to its VAX series of superminicomputers this year. There has been much speculation about whether DEC would enter the minisuper market with a standalone system of its own, but Brown believes the company would rather provide an attached processor for those customers needing it.

Big Blue maneuvers

Brown also believes IBM, which currently has a vector add-on for its 3090 mainframes, called VF for vector facility, will migrate a similar attachment downward into the 4300 mainframe area and into its new midrange 9370 arena. Furthermore, the current players in the minisuper market, says Brown, will continue to slash prices on existing systems and announce lower-priced machines such as Alliant Computer Systems Corp.'s $99,000 FX4, introduced in late 1987.

Regardless of the economic outlook, many executives feel that advances in technology will continue. "Looking forward, we don't see any major change, from the technology point of view," says NCR's Williamson. "There will be new price performance improvements brought about by technology like VLSI [very large scale integration]," says Williamson.

And improvements will come from advances in software. "There will be development done more in software over the next few years," in the high performance computer market, says IDC's Brown. And customers will place more importance on software, says Peter Appleton-Jones, president of minisuper maker Elxsi Ltd., in San Jose. "Software has become the standard customers are concerned with," says Appleton-Jones. "The [hardware] equipment is less important. □

BY VALERIE RICE

Peripherals: The plague of plummeting prices

Makers of everything from printers to disk drives find they must keep forcing prices down. 1988 will be no exception

Moderate prosperity seems to be the theme for 1988 in the peripherals industry. Although some segments of the market are better than others (disk drives are more profitable than printers, for example), most major segments are showing at least marginal growth, and industry executives are, on the whole, bullish on 1988. However, one problem continues to plague the peripherals industry: falling prices. "Every year it's the same," says John Boldt, associate director of the printer industry service at San Jose market research firm Dataquest Inc. "Performance and functionality go up and prices go down."

Prices are dropping substantially every year, and 1988 will be no exception. For example, disk drive prices drop an average of 25% to 40% per year, according to industry executives; and printers, terminals and add-in card prices also drop correspondingly.

But the industry is growing, even if revenue is not keeping pace with unit sales. Numbers from the two largest segments of the peripherals industry — printers and disk drives — substantiate this. Disk drive revenue will increase 15% over 1987, in 1988, according to Mountain View, California-based Disk/Trend Inc., while unit sales will increase 33% in 1988. Printer shipments in 1987 are likely to reach 5.3 million units, growing to 5.9 million units in 1988, according to Dataquest. Printer revenue will increase from $6.6 billion in 1987 to $7.0 billion in 1988.

Powering this growth are two of the biggest names in the personal computer industry: IBM and Apple Computer Inc. Their product introductions in 1987 — the Personal System/2 and the Macintosh II and SE, respectively — opened up new markets for peripherals, particularly in the areas of add-in cards, extra storage and enhanced monitors.

Yet 1988 is not so far removed from the tough times of 1985 and 1986, and vendors are worried about market shakeouts, particularly in the very crowded disk drive, printer and add-in board businesses. And no one is willing to predict the long-term impact of stock market fluctuations early last fall. What companies can and do address, however, is market overcrowding.

"There are an awful lot of companies out in the market right now," says Giacomo Versecci, marketing manager for Honeywell Bull Italia's worldwide printer operation. "It is hard to stand out in the crowd."

Vicious business

Disk/Trend's Robert Katzive notes that the disk drive industry is "fairly crowded. It's surprising how many companies are taking a shot at the market. There are 42 OEMs [original equipment manufacturers] of 380-megabyte drives, and a half dozen or more of 760MB drives. Not everybody can win. In fact, there are going to be very few winners." Even board maker Paradise Systems Inc. president Thomas Van Overbeck admits that "it's vicious out there."

Some industry executives are predicting that a consolidation will begin in 1988, prompted by pricing pressure. But others, noting the phenomenal success of start-up disk drive maker Conner Peripherals in 1987, feel that there may still be room for small aggressive companies with good ideas.

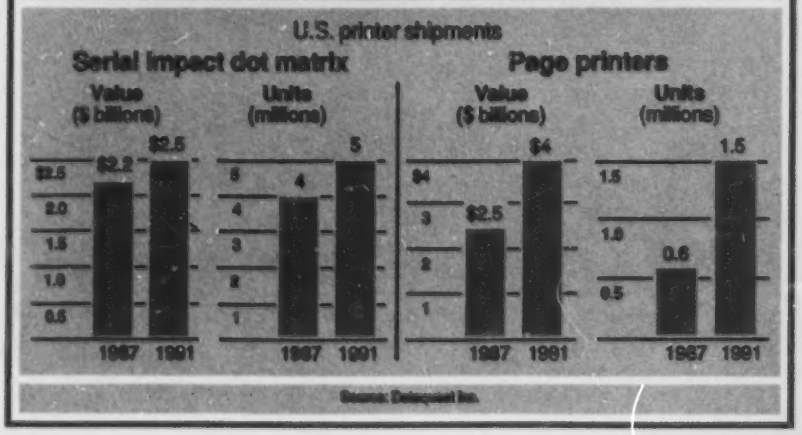
The terminals business — one of the older businesses in the peripherals sector — is probably the most settled to date. If there was a shakeout, it has come and gone, leaving three large companies, Ampex, TeleVideo Systems Inc. and Wyse Technology, and several small companies with the run of the market.

"There is going to be consolidation into 1988," says Ampex's John Murray, "but it is pretty clear who the leaders in the market are."

The terminals market is estimated to be a $5 billion retail market, of which about 60% is in the United States. Offshore manufacturing and pressure from both distributors and smaller players have caused "severe price erosion," Murray says, but he feels confident that 1988 will be a good year for the major companies

"In 1988 we will see strong pressure to keep the price steady and even more pressure on performance. This is a growth marketplace," he con-

Making money in the printer business is no picnic these days. Page printers offer the consolation of strong growth



tends. "Terminals are now approaching the low end of computers. They have more remote processing power."

One of the most volatile and crowded segments of the peripherals industry, the disk drive market has a sort of uncanny attraction for many players looking for volume business and high average selling prices. For those in the high end of the market, 1988 promises to be a growth year. In the low end, however, the competition and price erosion remain fierce.

Says Robert Oakely, marketing director of Microscience International Inc., "10MB disk drives are being given away, liquidated below the manufacturer's cost. Twenty megabit drives are not as profitable as they used to be, either."

Yet despite the lack of money to be made in the low end, the vast bulk of units shipped are in the sub-100MB range, according to Disk/Trend's Katzive. "Of the 17 million units expected to be shipped in 1988, 15 million of them are small diameter and under 100MB," he says.

In the low end of the market, Seagate is the biggest OEM company, Katzive says, noting that they might ship up to 3 million drives in 1987. However, he hastens to point out that, "they're not making as much money as they used to."

Where's the grim reaper?

But for the higher density manufacturers, "There is not a big grim reaper out there," Oakley says. "At worst, the disk industry will be in the growth mode. At best, we will see a tremendous percentage increase in 1988."

The bulk of the high-density drive business remains in the 5.25-inch format, although the newer 3.5-inch and the half-height formats are doing well also. Even 8-inch drives have their place, says Control Data Corp.'s marketing manager James Oughresby. He says that CDC continues to do a strong business in the larger drives, and expects that to continue through the early 1990s. CDC has also moved strongly into the 3.5-inch market, and Oughresby claims to have the highest capacity 3.5-inch drive on the market to date.

Disk drive revenue will increase 15% over 1987 this year, while unit sales will increase 33%

Capacity battles will continue to be an issue in the coming years, Katzive contends. One reason is that users can never seem to get enough memory. Workstation vendor Sun Microsystems Inc., for example, says it can never offer its customers too much storage, so it is constantly on the prowl for more density, not to mention good reliability and speed.

Drive maker Maxtor Inc. has placed its reputation firmly behind the very high-capacity and high-speed drives, says marketing vice president Robert Teal. The bulk of Maxtor's business through 1988 will continue to be 5.25-inch drives, but the densities should increase dramatically. "Our 190MB product is our cash cow currently," Teal says, "but the 380MB drive is in strong demand. Our 760MB drive may have the shortest product integration time of any product we have ever seen. Customers are accepting that product and integrating it instantly."

It's pretty tough to make money in the printer business right now. "Companies used to try to beat their competitors on price and performance," Dataquest's Boldt says. "Now that is going away. You can't beat them hands down. You just want to stay even."

Distribution is such a sensitive issue in printers that companies will sometimes sell products at a loss just to keep distribution channels available. Boldt says that he has seen price adjustments as little as $10, all done in an effort to stay even with the competition.

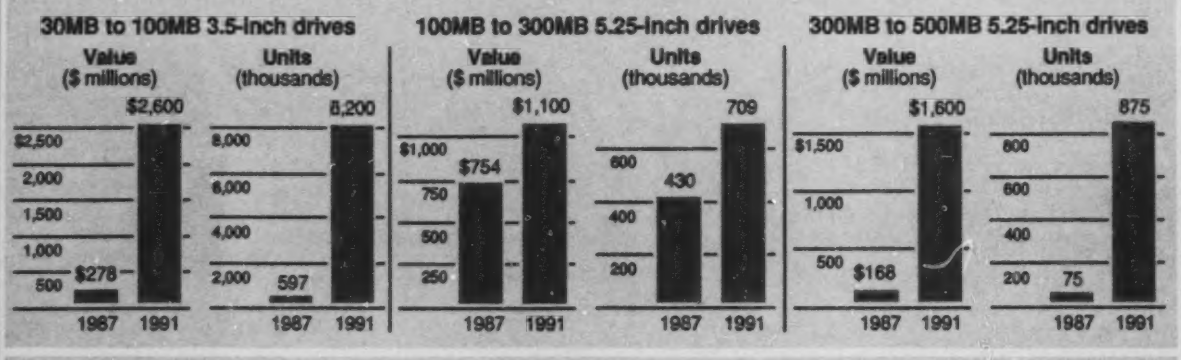
At Honeywell Bull, marketing manager Versecci says that his only strategy for survival worldwide is differentiation through higher functionality and better performance than other companies. One of the difficulties in printers, though, is not only the large number of players, but the large number of warring technologies.

Support for color

Honeywell Bull has decided to support color line printers, Versecci says, and the color is not an option. He says that if he were to wait for users to ask for color, he might wait for-

Makers of high-performance hard disk drives are scrambling to catch up with demand

U.S. high capacity disk drive shipments



Source: Disk/Trend Inc.

ever, and this way they will get used to color without having to pay a premium for it.

The largest-selling printer to date is Apple Computer Inc.'s ImageWriter, Boldt says, and it will likely continue in that role through 1988. Page printers, which are mostly laser printers, will account for 600,000 of all the printers shipped during 1987, a figure which is double that of 1986, according to Boldt. 1988 will continue to see growth in page printers, although probably not at the doubling rate of previous years.

Add-in boards are a great business to be in if the market is video, contends Paradise's Van Overbeck. Otherwise, it could be a difficult year. The reason is that IBM's Personal System/2, while spurring on sales in some areas, has cut off sales completely in others.

With so much functionality now included on the motherboard, there is very little room —or need — for add-in cards in traditional areas like enhanced speed, math coprocessors, and so forth.

Video is one good area for the IBM compatible market, Van Overbeck says, because users wanting to upgrade XTs or ATs to PS/2-like functionality only have to add a monitor, a 3.5-inch drive and a Video Graphics Adapter (VGA) card to have PS/2 functionality for much less money. That is where Paradise is hoping to position itself for the future.

"This marketplace continues to be exciting," Van Overbeck says. "If a major corporation is switching to PS/2s, what do you do with all the XTs and ATs? We think the market for video boards is really a VGA market."

"There are 20 million machines installed," he continues. "Say 5% are going to be compatible with the PS/2. That's 1 million boards. That's a big number."

For the add-in board business as a whole, competition and pricing pressure will soon start to drive companies out of the business, Van Overbeck believes. "We are becoming what systems integrators were. The people who will survive are vertically integrated. I don't think that by integrating someone else's chips a company can compete.

1988 will likely witness the add-in board industry's continued efforts to move more toward upgrade products for the installed systems base, rather than toward designed-in parts of a new system. □

BY ALDEN M. HAYASHI

Semiconductors: A dicey year ahead as growth cools

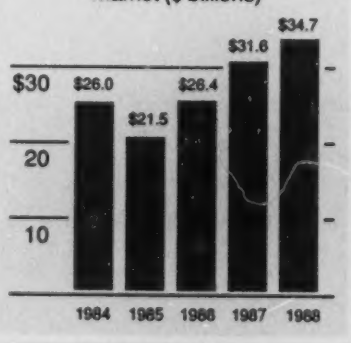
Wall Street's crash has made the chip industry nervous. So far it's business as usual, but for how much longer?

The mood was definitely upbeat at the annual dinner meeting of the Semiconductor Industry Association (SIA) last Oct. 1. After being battered by the calamitous recession of 1985-86, the bigwigs of the U.S. chip industry finally had reason for celebration. According to the market figures presented that night, worldwide semiconductor sales would end up soaring 21.8% in 1987 and 17.9% in 1988.

"Today is the day that we are officially declaring that Silicon Valley and the worldwide semiconductor industry is in the midst of a sustainable economic upturn," said Wilfred J. Corrigan, chairman of the board of LSI Logic Corp. of Milpitas, Calif. "At the same time, we are closing the books on one of the most painful downturns in our industry."

Forget those outrageous growth projections: The Wall Street crash will help chip sales to slacken off

Worldwide semiconductor market ($ billions)



Source: In-Stat Inc.

Later that month, the celebration continued at an industry conference held in Phoenix, Ariz., by Dataquest Inc., a market research firm headquartered in San Jose. At the annual gathering, Gene Norrett, vice president and director of Dataquest's Semiconductor Industry Group, managed to outdo the often overly optimistic SIA numbers by boldly forecasting a growth of 24% for 1988.

Then, on October 19, the stock market crashed.

"We are definitely less optimistic now and we are considering a change in our numbers," says Joseph K. Borgia, Dataquest semiconductor analyst. Borgia says that Dataquest's revised number will probably be around 15%. Other market researchers are predicting even lower growth. Integrated Circuit Engineering Corp. (ICE) and In-Stat Inc., both headquartered in Scottsdale, Ariz., are forecasting growth in the 10% range, respectable but much lower than the 20% surge of last year when worldwide semiconductor sales topped $31 billion, according to In-Stat. Interestingly enough, ICE was forecasting its cautious 10% figure months before the October stock market plunge. "We always felt that the steam of '87 would take away from the punch of '88," says William J. McClean, ICE research analyst.

Actually, the U.S. market should hold up better than other international markets, claims In-Stat's Beedle. He predicts that U.S. semiconductor sales will grow by 11.1% this year, down from 18.8% last year. During the same time period, the market in Japan will slow to a 8.4% growth, down from 15.5%, while the European market will slump at 5.5%, compared with 13.0% last year. The greatest slowdown, however, will occur in the ROW (rest of world) countries where market growth will plummet from a scorching 64.2% rate last

year to 20.1% this year, according to In-Stat's figures.

The trickle-down scenario

What semiconductor industry executives fear most is that Wall Street's recent conniptions will rattle consumer confidence leading to an overall economic recession, particularly in the United States. If that happens, businesses will be buying less computers, telecommunications gear and other electronics products and, consequently, the market for chips used in those products would plunge.

Although this trickle-down scenario has chilling implications, clearly no one in the industry is panicking. "Trying to guess what's going to happen, given the recent events on Wall Street, really just doesn't serve any purpose. Overall, we're still in good shape and on track for the medium to long term," asserts Kevin McGarity, vice president in charge of North America sales and marketing for the semiconductor group of Texas Instruments Inc., headquartered in Dallas.

"We're not changing any of our plans," asserts James A. Norling, executive vice president and general manager for the semiconductor products division of Motorola Inc. of Schaumburg, Ill. Indeed, Norling asserts that Motorola will proceed as planned with the building of a new factory later this year in Japan, per the company's joint venture with Toshiba Corp. of Tokyo.

Intel Corp. of Santa Clara also remains confident. According to Andrew S. Grove, chief executive, Intel will invest around $400 million in capital expenditures this year, up from $300 million last year and less than $200 million the year before. Still, Grove says, "The stock market has made us nervous and we are going to scrutinize our own business more carefully from now. Adds Motorola's Norling, "We're watching carefully and keeping our eyes on the horizon."

So far though, none of the chip vendors has complained about any sales slowdown. "Ordering levels have remained high," asserts Dataquest's Borgia. He explains that chip customers have continued to do well and have consequently continued to buy massive quantities of chips, so far at least.

In particular, the computer market is forecast to grow. "Our business is up substantially," says Hugh J. Lynch, a vice president in the Development and Production Division of NCR Corp., headquartered in Dayton, Ohio. "We've had seven consecutive quarters of double digit order growth," boasts Lynch, "And based on the computer demand we've been experiencing, we see a pretty strong seminconductor market out there." Last November, IBM chairman John F. Akers was also optimistic. In an address to securities analysts, he said that IBM had not experienced any downturn in orders since the stock market's collapse.

U.S. semiconductor sales should hold up better than in Japan and Europe. But ROW will slump

Telecommunications customers are also confident. The communications market should grow too. John S. Buchan, a vice president for Northern Telecom Inc. in Nashville, Tenn., says that he expects his company to buy about twice as many Motorola chips this year as it did last year. Although he says that half of the increase will be due to buying more Motorola chips in lieu of other chip companies' products, the other half will be due to a real increase in his company's semiconductor needs.

Consequently, TI's McGarity says, "We're still very confident . . . in the basic strength of the electronics industry." Nonetheless, pessimists predict that an overall economic recession is imminent, if not later this year, than surely in 1989. "The stock market is probably a precursor to other things," warns Jack Beedle, In-Stat president. Other market watchers assert that the first two quarters of this year will probably tell the story. "If the first half of the year is weak, then we'll really be in trouble because there just doesn't seem to be anything that would drive semiconductor growth in the second half," says Dataquest's Borgia.

Hamstrung expansion plans

A more direct effect of the stock market crash is that it might hamstring some companies' capital expansion plans. But luckily for most companies, the boom market last year allowed them to build up substantial cash reserves. "The stock market change *could* have been relevant to our ability to afford to make investments, but fortunately we have built up a $700 million cash position so we have no need for further cash infusions for the foreseeable future," says Intel's Grove. "We will be able to fund our pretty heavy investment program without being dependent on the capital market."

Indeed, Intel is fortunate. The company is on a roll as it tries to meet the soaring demand for its latest 80386 chips, the state-of-the-art 32-bit microprocessors. "We are running close to 100% of what our equipped facilities can produce," says Grove. Other companies are also bustling. "Most of our product lines are in allocation, or close to being in allocation," says James Townsend, strategic marketing manager for Toshiba America Inc. in Tustin, Calif.

But some of the smaller U.S. chip companies might be vulnerable to Wall Street's gyrations. Altera had scheduled an initial public offering last November but decided to scrub its plans after the October crash. "There's no sense in trying to go out there in this environment," says Rodney Smith, Altera president. "But," maintains Smith, "the good news is we didn't have to go public. We've got a strong balance sheet. We've got over $10 million in cash . . . so the stock market has not affected our operations at all. We'll just continue running our business as usual."

And that's the advice that most industry gurus are giving. What happened on Wall Street recently, says In-Stat's Beedle, "is something that I don't think we need to panic over. But rather we need to be aware of it and exercise caution and have contingency plans set aside just in case." As a final warning, Beedle adds, "The companies that exercise caution are going to come through very well. The companies that ignore facts are going to suffer." □

BY ALBERTO SOCOLOVSKY

Components: Growth areas in a slow-growth market

Not all the action is in silicon. SMT and other technologies are giving new life to passive components

Tony Hamilton's eyes brighten up considerably when he talks about semiconductors, less so when discussing connectors, and they get positively dim when the conversation turns to resistors. However, the changing countenance of Avnet Inc.'s chairman has more to do with the general economic outlook for those particular products, than with revenue derived from his Electronic Marketing Group (EMG).

Last year, EMG, the largest industrial electronics distributor in the United States, sold almost 70 cents of nonsemiconductor components for every dollar worth of semis. But while dollar projections for the U.S. semiconductor market call for an increase — ranging from 11% to 26% this year, over 1987 — growth may be limited to single digits for electromechanical, interconnection, and passive components. Even so, this market may add up to $14.7 billion in the United States this year.

Besides Hamilton's look, there are other signs that growth comes slowly for those components.

- There are the line cards at Hamilton/Avnet, Harper and Time Electronics (Avnet's component distributors), which show names of companies that have changed ownership more than once in the past few years, as well as companies that may do so this year.
- There are the membership rolls at the Electronic Industries Association's Components Group, which keep changing from divestitures and acquisitions.
- There are the leadtimes for most of these components, which, after lengthening in the last quarter of last year, show signs of stabilizing in 1988.

Application specific components offer manufacturers a welcome opportunity to make a profit

No start-ups

Nevertheless, there are some fast-track market segments. "There are no start-ups [to make passive components] in this country," says John L. Sprague, president of Sprague Electric Company. But there are three major growth areas in which Sprague, as well as most other suppliers, are investing, and where they expect to see sales and profits in 1988. These include application-specific components, surface-mount components and the automobile market.

Application specific (AS) is to these components what ASICs are to chips. Bourns Inc., for example, makes resistor-capacitor networks which are tailored to cutomers' requirements. For its Japanese customers, Bourns developed resistive trimmers housed in plastics optimized for the board soldering fluxes and temperatures common in that country. And Sprague builds complex networks but uses ceramics technology to make a monolithic component out of them.

For manufacturers accustomed to facing price competition from foreign vendors, AS components also offer manufacturers a welcome opportunity to make a profit. That's because the component's added value makes it worth more to the customer than the sum of its parts.

But Herbert J. Rowe, senior vice president for EIA's Components Group, worries that small manufacturers that develop AS components may not recover their costs if their customer's application doesn't fly. Just as with their colleagues in the gate array business, some companies which experiment with AS may have trouble getting paid for nonrecurring engineering costs.

Nobody ever called the components that were developed specifically

Growth may be limited to single digits for electromechanical, interconnection and passive components

U.S. market ($ millions)

	1987	1988
Capacitors	$2,200	$2,300
Connectors and interconnection components		
Backplanes	385	415
Coaxial	281	302
Cylindrical	869	947
Fiber-optic	73	68
Planar cable	268	291
Printed wiring	1,134	1,222
Rectangular	515	549
Sockets	252	267
Other	559	610
Printed circuit (bare) boards	1,800	2,150
Keyboards	400	450
Relays	770	793
Resistive components		
Potentiometers and trimmers	250	250
Fixed	290	300
Networks	150	180
Switches	520	540
Other components* ($ billions)	$3.0	$3.1
Total ($ billions)	$13.7	$14.7

*Batteries, cables, coils, crystals, displays, enclosures, fans, EMI filters, motors

Sources: Avnet, Bourns, Cherry Electrical Products, ELECTRONIC BUSINESS, Electronicast, Electronic Industries Association, Fleck Telesis, Henderson Ventures, Potter & Brumfield

for the automotive market "application specific." But that's what they were. In fact, the automotive market requires more custom applications than computer or communications markets. For the electronic speedometer of GM cars, for example, Thomas & Betts Corp. developed a socket into which Delco, a division of General Motors Corp., drops in and reflow-solders an EPROM chip. T&B, as well as most domestic suppliers, would also like to have Japanese auto makers that manufacture in the United States as customers. But first they must compete for that business with Japanese suppliers that are following their clients across the Pacific.

This can be difficult, though. "We make relays for autos," says Roy H. Slavin, president of relay maker Potter & Brumfield, "so we participate in this booming market. And our quality level is higher than the Japanese relays." But P&B's efforts to supply the U.S. factories of Japanese auto makers have been frustrated, Slavin says, because "they specify the components in Japan."

Auto makers, of course, are also committed to surface-mount technology (SMT), another growth area. Their designs call for using more of these components in 1988 and beyond, because SMT saves space and allows the incorporation of more electronic systems under the hood.

SMT started with passive components, so the technology may be more advanced in some cases than it is with semiconductors. According to N.V. Philips' Electronic Component and Materials (Elcoma) division, the largest manufacturer of components in the world and the inventor of SMT, 50% of the world's resistors and 44% of the capacitors used in 1990 will be surface-mount devices, versus 39% of ICs.

On the other hand, Ken Fleck of market researcher Fleck Telesis, says SMT has made inroads in only two types of interconnection components: IC sockets and printed circuit board connectors. In 1987, only 4% of the sockets were SM; the penetration may go up to 7% this year and to 30% in 1990, predicts Fleck. "Resistors and capacitors have only two or three leads," notes Fleck, "so it's easy for a machine to place them on the board and make contact."

Surface mount for passive components is a growth market

Worldwide demand for surface mount capacitors and resistors

	1985		1990	
	Units (billions)	Percentage of total	Units (billions)	Percentage of total
Capacitors	20.6	26%	48.6	44%
Resistors	17.3	22%	50.5	50%

Source: Philips Electronic Components and Materials

The big get bigger

At press time, AMP Inc., the largest maker of connectors and interconnection components, and eighth-ranked Molex, were bidding for ownership of Matrix Science Corp. The acquisition would open for either suitor the $1.6 billion U.S. military connector market, a market that Allied-Signal Inc. exited last year by divesting Amphenol and Bendix.

In Allied-Signal's case, the divisions were sold to an investment group that retains ownership in the United States. But EIA's Rowe finds it distressing that some components manufacturers end up owned by foreign companies.

OEM inventories are at their lowest level in 10 years thanks to programs such as just-in-time inventory control

"It makes it so much more difficult [for the United States] to regain its preeminence in component technology," Rowe says. The most visible recent example was the acquisition of TRW's capacitor operation by ShiZuki Electric Com. Inc. But the largest foreign acquisitor last year was Philips, which — by buying the remaining 42% of North American Philips — also bought NAP's preeminent position as the largest maker of nonsemiconductor components in the United States.

Conversely, TRW Inc., once second only to NAP as a broad-based components maker, has gone out of the business of manufacturing electromechanical and passive components, and it is still trying to divest its Connector Components division. There will be more divestitures this year. "Even big companies can't invest everywhere," says P&B's Slavin. (His own company was sold by AMF Inc. to Siemens AG two years ago.) But he sees a good side to divestitures, because the manufacturers end up in the hands of management who, like Siemens, are committed to component technology. "It's healthy for Sprague Electric to be a public company again," says Sprague.

Leadtimes and inventories

Meanwhile, Daniel A. Bechtel, director of corporate materials for Hewlett-Packard Co., notes that component makers have improved leadtimes. This has helped HP and many other electronic equipment manufacturers to reduce their inventories.

Market watcher Ed Henderson says that original equipment manufacturing (OEM) inventories are today at the lowest level in 10 years, thanks to programs such as just-in-time (JIT) inventory control, which helps cut component leadtimes.

Electronics Purchasing magazine's leadtime index shows that leadtimes for most components rose throughout 1987, but Cahners Economics, which uses the magazine data as a base, forecasts that the increase will slow down in the first half of 1988. Cahners says leadtimes may actually go down in the second half. The leadtime problem affects primarily military-specification connectors, an important market in dollars but made up of relatively small quantities of high-priced connectors. James Noll, director for materials at Northrop Corp.'s Defense Systems Division, complains that large connector suppliers lack the flexibility to provide special designs, or even slight modifications of standard connectors, on short order. "The [long] leadtimes pretty well stick," he laments. □

BY DAVID CARD

CAD/CAM/CAE: A return to double-digit growth

Despite Wall Street's recent woes, 1988 will show reasonable upturn for CAD/CAM/CAE vendors

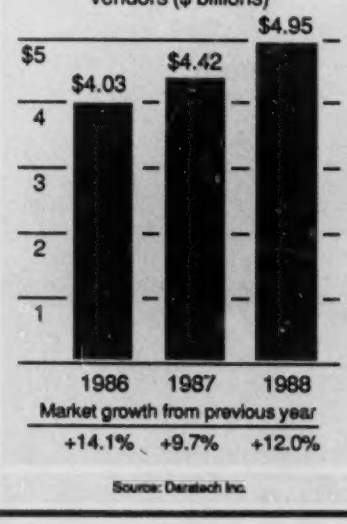
Slaves to capital equipment budgets, suppliers of CAD/CAM and CAE systems are anxiously watching for fallout from last October's Wall Street crash. If engineering and data-processing managers curtail spending, sales of systems for computer-aided design, manufacturing and engineering will rise only 10%, forecasts Charles Foundyller, president of market research firm Daratech Inc. But if capital spending ignores stock market uncertainty, world sales from U.S. vendors will go up 12% this year, to around $4.95 billion.

"The burning issue is the stock market crash. Are we or are we not going to have a recession, inflation or some other disaster?" Foundyller asks rhetorically. "Nobody really knows which way it's going to go. Most people say that they are choosing to ignore it." Adds Beth Tucker-Romig, an analyst who follows CAD/CAM/CAE at market researcher Dataquest Inc.: "One of the biggest determining factors wil be capital spending dependency on what happened on Wall Street. People will be pretty cautious in the first quarter." In fact, she says, that caution could extend through the first half of the year.

According to Daratech, the company with the fastest growth last year was electronics CAE leader Mentor Graphics Corp. Mentor president Gerard Langeler sees 15% to 20% industry growth. "The electronics segment is in pretty healthy shape, unless the stock market throws everything into a cocked hat — and I don't think it will," Langeler says. "I would say it looks pretty good. The people who buy electronics are reasonably healthy. The semiconductor companies are as healthy as they've been in some time. The computer companies are showing good quarterly reports. The aerospace companies are not as buoyant as they once were but the very rapid movement of technology has not abated, even through the business ups and downs."

Outside of the electronics segment, things still look pretty good, according to Daratech's second-fastest growing CAD/CAM manufacturer, Prime Computer Inc. Robert Fischer, president of Prime's CAD/CAM group, pretty much agrees with Langeler: "I would say that separate from the stock market turmoil, 1988 will show some improvement in the overall CAD/CAM market . . . It could get up to an industry growth rate of 15% or so." Like Prime, Intergraph Corp. has a strong mechanical slant, but George Ralls, responsible for strategic marketing in electronics, says that in electronics, Intergraph should easily see 20% growth over its 1987 $80 million in sales. "We've moved from 'guarded optimism' to 'real optimism,'" Ralls says.

CAD/CAM/CAE should bounce back — If Wall Street's crash hasn't induced a terror of capital spending among managers



There's at least one prophet of gloom in the industry. Michael Smith, a marketing director for Schlumberger Ltd.'s Applicon unit, sees drastic price cutting — due mostly to cheaper 32-bit engineering workstations — cutting into suppliers' top lines. "I think the whole market won't grow significantly because of prices coming down," Smith says. He says some Applicon lines have seen 45% to 60% price reductions recently. "Overall revenue will decline," Smith says, "I'm also sort of assuming a recession [this] year." Analyst Foundyller agrees on the effects of price erosion: "It's very easy making units grow; it's very difficult making revenues grow."

Consolidation at last

A trend sure to continue in 1988 is a thinning of the ranks. "We're definitely seeing the industry consolidation that has been predicted for some time," says Mentor's Langeler, "I don't think it's all done yet." Quips Prime's Fischer: "None of us can quite figure out why the shakeout that is inevitable in CAD/CAM hasn't occurred yet." Applicon has been hit by sales shrinkage and layoffs; McDonnell Douglas Corp.'s CAD division is only just profitable and General Electric Co.'s Calma is "just hanging on," according to Foundyller.

Meanwhile, there was a handful of mergers in electronics CAE last year, and Mentor acquired two companies. Mentor's mergers were not indicative so much of a shakeout as a broadening of the definition of CAE, Langeler says. Mentor agreed to merge with Caedent Corp. and Integrated Measurement Systems Corp. (IMS). Both companies have strong links to test: Caedent makes a simulator and faultgrader, and IMS makes a test system for prototype custom chips. The design-to-test connection can come from the opposite direction as well. Automatic test equipment leader Teradyne Inc. took a further step into CAE (it already sells a simulator) by agreeing to acquire another simulator company, Aida Corp., late last year.

The low end of the CAD market was particularly merger and acquisition happy — Intergraph took a 50%

equity position in, and Prime acquired outright, PC drafting companies. "One of the bottom-line messages is that, with Wall Street quote, 'drying up,' capital is harder to come by to buy market share. Mergers and acquisitions — although they are never easy — are an easier way to gain market share," Dataquest's Tucker-Romig says. The number of start-ups versus shutdowns has been almost equal for the last three years, she says.

Prime went through a flurry of deal-making last year. Besides buying Versacad Corp., a firm that sells software for personal computers, Prime brought out a high-end graphics workstation it developed along with Silicon Graphics Computer Systems and a medium-scale model from Sun Microsystems Inc. "One of the things I learned the hard way is that I don't think you can make money . . . as a value-added reseller of somebody else's hardware," Prime's Fischer says.

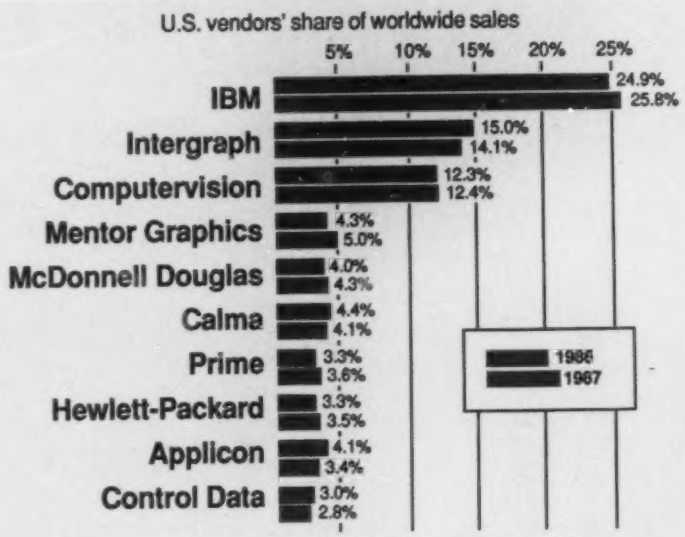
So why the deals? "Versacad —We just went out and bought them, so we can make money there," Fischer says. "We couldn't afford to buy Sun. That's a straight OEM deal and we won't make much money on that." A midrange computer was a must, Fischer says, and any Sun sales should "drag along some 50 Series computers" that Prime makes. Prime owns a piece of Silicon Graphics, so it was able to get a good deal on the hardware; and the two companies also divvied up marketing areas. "It's still going to be tight," Fischer says.

To bundle or not?

Much has been written about the trend of "unbundling" design software, that is, selling it separately from the computers it runs on. But in fact, none of the biggest CAD/CAM suppliers do it unless they absolutely have to. Actually, just the opposite is true, as the industry becomes dominated by computer companies like IBM and Prime, and systems integrators such as Intergraph start to build their own workstations.

Daratech's Foundyller explains that it is not only a matter of the big companies wanting to maintain their gross margins. They are afraid, he says, of losing control: losing account control by being the one sales point; and losing installation control by having to wait for hardware and operating environment control, by, for example, being forced to keep up with the latest operating system updates.

The CAD/CAM rankings: Mentor picks up share and Big Blue just keeps getting more of the market



Source: Daratech Inc.

"For [customers like] GM or Uncle Sam, they will do that," Foundyller says of companies unbundling software, "For anybody else, they won't. Systems integrators have a lot more trouble unbundling than computer vendors do."

"It's becoming an application that can best be sold by general-purpose hardware and system-software companies," says Fischer, whose company fits into the first category. "I've got to believe that at some point DEC will get into the CAD/CAM, CIM business on their own," he adds. Fischer likes to think of CAD/CAM as a piece of computer-integrated manufacturing, a train of thought that most of the big computer companies, including Digital Equipment Corp., like to board.

If engineering and data-processing managers curtail spending, sales of CAD/CAM/CAE systems will rise only 10%

"It is a systems business, they're right, but the question is: do you have to make the whole system?" asks Mentor's Langeler. He resells hardware from Apollo Computer Inc. Buying bits and pieces from a variety of vendors, Langeler says, begs "the 'Ghostbusters' question: Who you gonna call?" He thinks it likely that only the most sophisticated customers will want to deal with multiple suppliers. Applicon's Smith agrees: "As corny as it might sound, customers still want turnkey systems."

Dataquest's Tucker-Romig does not think that will hold up much longer. "Large companies have the most workstations, and they've got the voice and the pull," she says. "If your name is Hughes, you can back Mentor into a corner and they'll unbundle." She thinks that amount of pull, particularly in cutting deals with the hardware companies, will force the CAD/CAM suppliers to go software-only. "It's something they'll have to do," she says. "Hardware has not really gotten to the saturation point, but people are not going to buy as much as they did in the past." Dataquest forecasts sales growth of CAD/CAM hardware, compounded annually through 1991, to be at a rate of negative 1%, while software clocks in at over 20%. □

BY CAROL SUBY

Production equipment: a high-wire balancing act

Sales of everything from steppers to etchers will grow fast in early 1988. But look out for a slowdown in the second half

In these trying times, running a semiconductor equipment business is a bit like bicycling across a high-wire while balancing a cup of water on your forehead. Last October, just when everyone agreed that the upturn had arrived, the stock market slipped and fell. Talk of healthy backlogs and a return to profits quickly turned to questions of economic recession and its impact on the electronics industry. Once again, equipment vendors and their customers — the semiconductor manufacturers — are being faced with difficult forecasting decisions.

Despite the fact that many chip houses are nearing 100% capacity, both equipment vendors and their chip-building customers continue to be "cautiously optimistic." However, if the semiconductor industry as a whole sticks to the spending plans it had before October's Wall Street wash-out, 1988 should be a good year for its equipment vendors.

Worldwide sales of semiconductor manufacturing equipment — including wafer fabrication, assembly and test equipment — are forecast to grow 24%, reaching $7.1 billion by year's end, according to San Jose-based VLSI Research Inc. And, the sun is shining on just about every kind of production equipment.

"Everything is hot," says G. Daniel Hutcheson, director of VLSI Research. "The changeover to fine line widths — anything below 1.5 microns — is happening much faster than anyone expected. It's eating up capacity." But leading-edge equipment for state-of-the-art chips is not all that's selling.

Worldwide production of semiconductors is up considerably — growing 22% in 1987 to $44.5 billion and expected to grow another 23% this year to $54.7 billion — according to Joseph Grenier, senior industry analyst at San Jose market research firm Dataquest Inc. And the chip builders, which had been canceling equipment orders or putting them on hold, are now buying to retool older fab lines or to increase capacity across their product lines.

As a result, the equipment vendors are selling as much of their older-generation hardware as their newest-generation machines. In some instances "it's as if the old purchase orders that were canceled during the downturn are now being dusted off and sent in," says Stephen Balog, an analyst with New York City investment brokerage firm Prudential-Bache Securities Inc. Balog points to a "surprising resurgence" in demand for diffusion tubes, which, he says, were intended to be displaced by the newer chemical vapor deposition (CVD) equipment. Instead, Thermco Systems Inc., a major manufacturer of these tubes, has recently doubled its backlog from 100 tubes to 200 tubes, according to Balog.

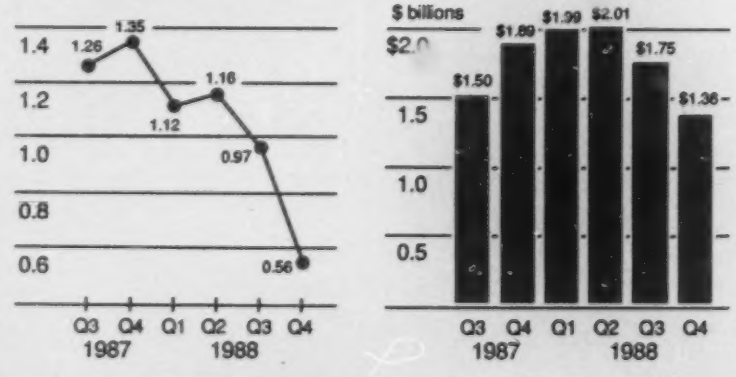
Worldwide sales of chip-making equipment are forecast to grow 24%, reaching $7.1 billion by the end of the year

Retooling older lines

Other equipment vendors are seeing more of the same. Production equipment giant Perkin-Elmer Corp. is selling a mix of equipment, not just its state-of-the-art gear. "We see both kinds of buying," says Stephen A. Reber, director of lithography equipment at the company's Norwalk, Conn., headquarters. According to Reber, a lot of older semiconductor production lines are being retooled; demand for bipolar equipment — an older manufacturing technology — is still growing; and, a lot of equipment is being purchased for 1.1 micron to 1.2 micron lines in production.

And, at Nikon Precision Inc., the U.S. subsidiary of Nippon Kogaku K.K. of Japan, about half of the equipment the company sells is for use in next-generation design rules and the other half is for retooling, says Michael Powell, vice president, marketing and services at Nikon's

Most of this year's growth in sales of semiconductor production equipment will take place in the first half of 1988



Source: VLSI Research Inc.

San Bruno, Calif., headquarters. A year ago, approximately 80% of sales were for leading-edge applications.

In addition, the buyers are as broad-based as the types of equipment that is in demand. From the major chip houses to the smaller specialty chip shops, fab floor space — idle for several years — is now filling up and, in some instances, new fabs are being built. At Texas Instruments Inc., leading edge products — such as dynamic RAMs and high-end logic chips — are "pushing capacity to its limits," says a company spokesman at TI's Semiconductor Group in Dallas. For example, TI's Houston fab — where 1-megabit DRAMs are manufactured — was half empty a year ago, but is now being fully utilized.

Capital spending plans for Silicon Systems Inc., an application-specific IC house based in Tustin, Calif., are being increased from 15% of 1987 sales to 20% of 1988 sales, according to Roy Lloyd, director of materiel. Already, SSI has taken delivery on a stepper — a million-dollar wafer-fabrication machine — as well as on three pieces of etch equipment, and "a whole slew of test equipment for the [back] end," according to Lloyd. The company's drive toward smaller geometries — line widths — is pushing some of these capital equipment expenditures, Lloyd adds.

Another ASIC house, VLSI Technology Inc., has been on an ambitious spending plan for some time while it retools its headquarters fab in San Jose and builds a new fab in San Antonio, Texas. However, after October's stock market crash, company executives quickly gathered to reconsider their 1988 spending plans. A decision was reached to keep its $50 million capital equipment budget for 1988 intact. (The company's 1987 equipment budget was $40 million.) Executives opted to look at other areas where cuts might be made if changes in the marketplace warranted such actions, according to a company spokeswoman.

Such aggressive capital spending plans are not limited to U.S. buyers. "In Japan, which was dormant for six to nine months, we're now doing a surprising amount of business," says Reber at Perkin-Elmer. And, PE is not alone in raking in the yen.

U.S. vendor Applied Materials Inc. — Japan's market leader in both epitaxial processing and plasma etch systems — is also experiencing a resurgence of business in Japan. According to Applied's senior vice president, James Bagley, in Japan, "there has been a 50% to 60% increase in activity [regarding] actual bookings and requests for quotes." But the buying doesn't appear to be broad based, he adds. Japanese customers are buying for two product types — ASICs and CMOS — and are looking to add capacity to support 1Mb production and 4Mb qualification, according to Bagley.

The bad news

All of this good news, however, covers only the first half of the year.

The book-to-sale ratio is expected to peak at 1.16 by mid-1988 and slow to 0.56 by the end of the year

In fact, for the equipment sector, more than two-thirds of this year's growth will take place during the first half of 1988. The book-to-sale ratio is expected to peak at 1.16 by the end of the second half of 1988, and then slow to 0.56 by the end of the year, according to VLSI Research. Despite the eventual tapering off of orders, "I don't think we'll see the boom/bust cycle we saw in 1984," says Hutcheson of VLSI Research.

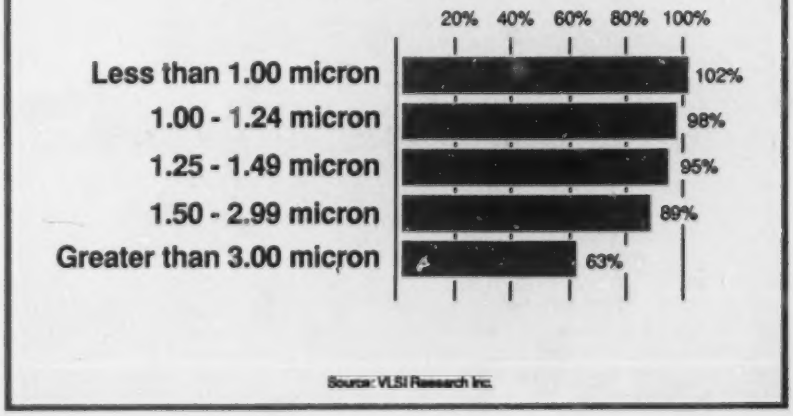
U.S. equipment vendors have "been to school" since that time, and by mid-1988 the lessons learned will be put to the test. Better business practices such as closer vendor/customer relationships, the scrutinizing of build forecasts, and keeping the lid on inventory have taken hold.

Today, production equipment vendors, "no longer sell just pieces of equipment. You have to sell the process," says Tony Jurvetson, president of Varian Associates' Semiconductor Equipment Group, in Palo Alto, Calif. At Varian, laboratories have been added where customers can come in and work on solutions. This sort of duplicate of a customer facility is very expensive, but also quite necessary, says Jurvetson.

Being so closely involved with the customer is becoming a key ingredient to success in a market that is developing into a globalized industry. Competition is no longer limited by national borders. In fact, several U.S. equipment vendors — Applied Materials, for example — have strongholds in various segments of the Japanese marketplace. At the same time, Japanese equipment vendors, including Nikon and Canon USA, are gaining shares of the U.S. marketplace.

However, the idea that Japan is getting stronger in the United States is "a myth," says Dataquest's Grenier. Pointing to Japan's less than 10% share of the U.S. wafer production equipment market, Grenier suggests that in this instance, "Japan could be demanding equal access in the U.S." □

Running at full capacity, many submicron chip makers need all the production equipment they can get



BY DAVID CARD

Test: An $8 billion market looks up in 1988

ATE is picking up the pace, thanks to strong chip sales. Instrument business will be worth writing home about too

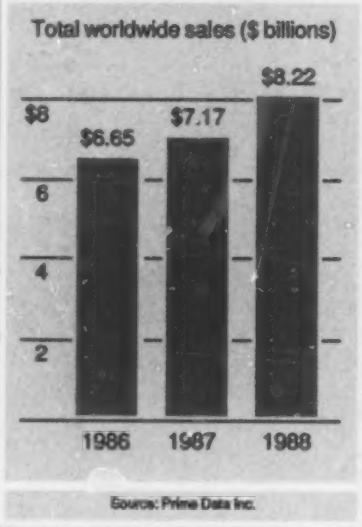
While it isn't exactly racing along, the test and measurement industry is growing solidly again. Barring any disastrous long-term effects from last October's stock market tumble, world sales should be up by well over 13% this year, to over $8 billion, according to market watcher Prime Data Inc. of San Jose. That's in comparison to a sluggish 7% annual growth rate last year.

"In general, 1988 is going to show strong growth," says Prime Data's Galen Wampler. Wall Street's grumbling bears "are not reflective of the industry," Wampler says. "The whole economy affects test instruments, but the stock market affects the psychology of the economy." Tektronix Inc. executive vice president Willem Velsink sees October's stock shock as a much needed, if drastic correction, and envisions a possible surge of takeovers. But he concludes: "I don't see the major recession. I don't see any real booming economy either."

Sales of automatic test equipment, which paced the overall T&M market last year, should once again gain momentum on the strength of the semiconductor industry, adds Kenneth Neff, who tracks the ATE sector for Prime Data. World sales should grow 18.8% in 1988, to reach a total of $1.99 billion. Neff says that he's also assuming little negative effect from Wall Street. But test suppliers had better take advantage of the mini-boom while they can — Prime Data is bearish on 1989. Neff says next year will slow, maybe even to the point of a recession. "You can pick your date for a recession and I'm sure you'll find somebody to fill it," Neff quips grimly.

Until then, "Bookings are up, business has definitely turned," says Edward Rogas Jr., vice president of the Semiconductor Test Division of ATE maker Teradyne Inc. As opposed to last year, chip companies are starting to buy production line machines, rather than the odd R&D tester for advanced product development. "We're seeing production orders as well as engineering orders," Rogas confirms. Teradyne is even adding to its own production capacity for some lines.

The test market, while it isn't exactly racing along, is growing steadily



World sales of ATE should grow 18.8% in 1988 to reach a total of $1.99 billion

Japanese chip tester Advantest Corp. echoes Teradyne's sentiments. "Certainly the indications are encouraging," says Advantest's U.S. president, Frederick Bihler. U.S. chip and computer companies "are starting to spend money." Bihler sees 15% growth into the first quarter, then another 15% in the six months following that. Another test company, LTX Corp., is not so sure things have turned around. Says president Graham Miller: "If there is [a turnaround for semiconductors], it's very spotty." LTX competitor Attain Inc. agrees. Says marketing manager Kenneth Chastain: "Things are picking up somewhat, but we're the tail end of the dog. The semiconductor companies have to pick up first, then we come along six months later."

A consensus is perhaps best expressed by John Zapf, a marketing manager at board tester GenRad Inc. "Nobody would say the business is booming, but it has rebounded. We're starting to see capacity buys. For years, there was no such thing," he says. Prime Data's Neff says that the board test industry, which was slower to slump, should likewise be slower to recover than the semiconductor test industry. John Scruggs, general manager for instrument giant Hewlett-Packard Co.'s board test unit, says, "We really believe we can see some real growth coming." Scruggs forecasts double-digit sales expansion, and is particularly keen on the telecommunications market. GenRad's Zapf has his own favorite hot market: "There are half a dozen PC clone makers doing well and buying from us."

Smoother sailing

It looks as if the sailing has smoothed in test segments other than ATE, as well. "We had a flat first quarter, but there was a comeback in the second," says Richard Jensen, vice president of Applied Microsystems Corp., a maker of microprocessor emulators. "We weren't much different from the rest of the T&M industry where we thought the world had stopped buying *anything* in the first quarter." Jensen says that Applied had $17.5 million in sales last year, and should continue its roughly 20% annual growth rate. Prime Data's Wampler says that microprocessor development systems, which incorporate emulators to write and debug software in systems, should at least track the general test market growth rate. Sales dollars had slumped recently, as suppliers began plugging development systems into

PCs and 32-bit workstations, rather than selling built-in computers.

In fact, Jensen sees the lure of the PC fading already, as true engineering workstations drop in price. "The PC opened up the entire [development system] business. But workstations are the trucks that are going to drive through the hole," Jensen says. He expects that the next wave of workstations could be priced as low as $3,500 per unit.

Development systems sales may be coming along nicely, but digital oscilloscopes are the real hot spot in instruments. Prime Data forecasts sales growth of over 25% this year in this sector. William Whitward, director of N.V. Philips' T&M business unit, says that Philips' biggest U.S. market is oscilloscopes. "And it's one of the most interesting, with the growth of digital oscilloscopes," he says. Even so, Philips, after a long hard go at the U.S. instruments market by itself, "did not meet the targets we wanted in the U.S.," Whitward admits. So it bought into the market.

Last fall, Philips put the finishing touches on a deal that gave it a 7.5% share of John Fluke Manufacturing Company Inc., thereby guaranteeing instant U.S. presence. Says Wampler of the deal: "From the perspective of the U.S., Philips has a lot to gain. From Fluke's perspective, they get a little more sales, but a lot more profits." Wampler thinks it is a good match overall, bringing the combined alliance into a strong No. 3 position in the world instrumentation market and closing the gap behind the No. 2 company, Tektronix. (HP is still a clear first.) "The test instrument market is going to keep getting more competitive, and this allows them to have a full product line, yet to concentrate on their own areas of expertise. That way, they can get the sophisticated instruments you need to tie into computer-aided engineering," Wampler says.

Digital oscilloscopes are the real hot spot in instruments. Prime Data forecasts sales growth of over 25% this year in this sector

Beefing up business

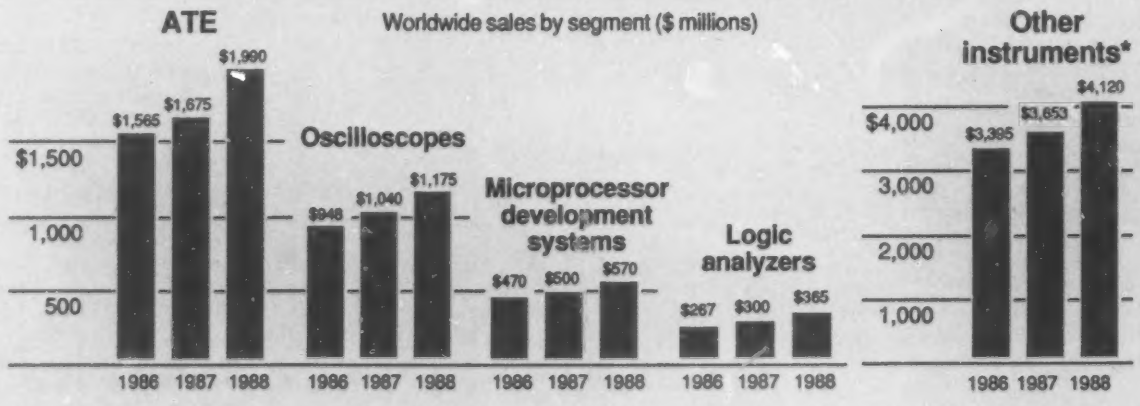
Fluke chairman John Fluke Jr. says his company can beef up Philips' business with the U.S. government. "If you're not in on the key government contracts, you're kidding yourself," Fluke says. "One of Philips' weaknesses was that they were not bidding on those aggressively enough." He says Fluke eventually could manufacture some Philips products in the United States.

Last July, five of the leading test instrument companies — Colorado Data Systems Inc., HP, Racal Dana Instruments Inc., Tektronix and Wavetek Corp. — took the wraps off a new set of specifications for modular instrument cards that they hope will become an industry standard. The goal of the so-called VXIbus, (for VMEbus extensions for instrumentation), is similar to that of an HP bus that it threw out to the world. HP's bus — now known as the IEEE 488 standard — became widely accepted by most instrument companies as the method to cluster instruments and control them from a single computer.

Prime Data's Wampler estimates that over 60% of all instruments sold are 488-oriented. "I don't think that the VXIbus will have a dramatic impact on 1988," Wampler says. But he thinks that in 10 years VXIbus could represent 20% or more of all instrument sales.

Tektronix chief marketing officer Philip Robinson speaks in a similar vein: "Personally, I think people will look back in five years and say this is one of the most significant events in the industry, but in one year, you won't be able to tell much." For one thing, he does not think the proposed standard will compete with the 488 standard: "We all have considerable investments in 488 instruments." However, he thinks it has the potential to be just as big an influence over the years as the HP standard has been. □

ATE picks up the pace in test growth. Meanwhile, digital scope sales are propping up the oscilloscope market



* Includes digital multimeters, voltmeters and signal generators

Source: Prime Data Inc.

BY STEVEN TITCH

Telecom gear: Coming through loud and clear

Developments in transmission equipment will drive telecom growth in 1988. Intelligent networks are already on the way

If this were Hollywood, the slogan would be "10 Years in the Making." Not that any of the usual motion picture promotion gimmicks are needed; the telecommunications industry has been hyping the convergence of voice and data since the late '70s. At last, it is beginning to happen.

The process brings together all the familiar telecom buzzwords of the '80s: integrated service digital network (ISDN); intelligent networks; local area networks (LANs); the T1 transmission specification; and network management. No longer is there a finite point where a private network ends and the public switched network begins, just as there is no longer a solid division between switching and transmission equipment.

If anything, these lines will become more diffuse as technology marches into 1988. "There's more distributed intelligence in the network. I'm having a hard time determining where switching ends and transmission begins," says Maria Sbrilli, an analyst with Smith Barney, Harris, Upham & Company Inc., New York City.

No matter where the division is made, transmission equipment will drive telecommunications growth in 1988. Dataquest Inc., a San Jose-based market research firm, projects 7% annual growth in 1988 for the entire industry. Dataquest estimates $155 billion in total revenue for the U.S. telecommunications industry by the end of 1987, with growth to $203 billion in 1991.

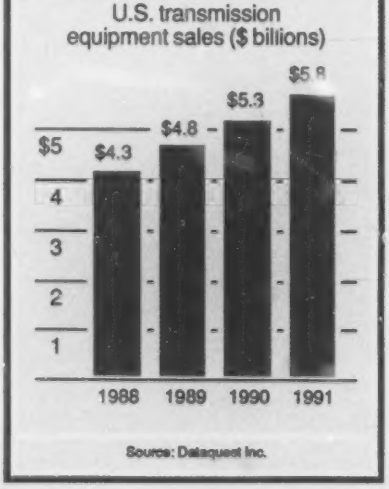
Sales of central office (CO) switches, the big ticket machines that switch and route local and long distance calls, will plateau at $3 billion and stay there until 1991.

"Growth is slowing in the CO market," says Vic Krueger, vice president of telecommunications industry services at Dataquest. "The old electromechanical switches are being replaced quickly. That replacement requirement is now diminishing."

Krueger says 1992 will be the first year CO sales will again grow significantly. That will be triggered as telephone companies begin to replace the analog stored-program-controlled switches that now serve approximately 50% of the lines in the national public switched network. These systems are expected to remain in service until their depreciation runs its full course, Krueger says.

But heavier demand for digital transmission equipment will pick up much of the slack. Intelligent network technologies such as ISDN require end-to-end digital equipment, and fiber-optic electronic components, digital loop carrier gear, and equipment that provides subscribers with special services will be finding their way into the network in great numbers. "Electronics has been rather late in entering the loop, which has historically been dominated by copper wire," Krueger says. "Now, the reliability of the new electronics has been convincingly proven."

Heavier demand for digital transmission equipment will help drive sales of telecom equipment this year



Dataquest forecasts a 10.4% annual growth rate for sales of transmission equipment through 1991, when total industry sales for this market segment should total $5.8 billion, compared with the estimated $4.3 billion in transmission business in 1988.

Satellite down-trend

Kenneth Bosomworth, president of market research firm International Resource Development, New Canaan, Conn., agrees. "There's going to be a downward trend in satellites, in fiber-optic cable, in private branch exchanges (PBXs) and in CO switches," he says. "However, there's going to be an upward trend in T1 multiplexers, modems and a strong upward trend in specialty voice service equipment, such as incoming call processors."

The only variable that could effect 1988 revenue has been the stock market tremors on Wall Street, and even that's proving debatable. In November, many pundits were talking about the possibility of a recession, and telecommunications analysts were split on how strong an effect it might exert on the industry. "In past recessions, AT&T's stock has done well," notes John Bain, senior vice president of New York City investment brokerage Shearson Lehman Brothers. "But we have not had a recession since the Regional Bell Operating Companies came into existence. We don't know what might happen."

Bain thinks carriers would be hardest hit because calling tends to drop during times of tighter money. Because a carrier's revenue stream is directly tied to the volume of calls placed on its network, a decrease in calling will hit it directly in the wallet. The knock-on effect is obvious: "Capital expenditures go right out the window," Bain says.

Others, such as Krueger, believe that telecom construction budgets have already been set in motion and if there is a major economic downturn, it would have little influence in changing the telecom companies' course. The Dataquest anaylst says market watchers would expect customer premises equipment would be affected more, and telephone services

to a lesser degree. "People don't disconnect their phones during a recession. Equipment used by the telecom companies as part of the network is typically not affected. Long term plans have already been made," Krueger says.

Recession or not, companies are lining up to grab more market share. AT&T, which has long dominated the transmission market, though still stocked with a quality array of wares, appears more vulnerable than ever to competition. Northern Telecom Ltd. has expanded its transmission equipment line through a joint venture with Britain's Standard Telephone & Cables. Meanwhile, Plessey Company Plc has merged its telecommunications operations with similar operations of fellow British company General Electric Company Plc (not connected with General Electric Co. in the United States). Not only will this make Britain more competitive in global switching markets, but it offers Plessey, which already owns Lake Mary, Florida-based Stromberg-Carlson Corp., a solid base of transmission technology to market on American shores.

In addition, Siemens AG of West Germany, is shaping up its Transmission Systems subsidiary in Phoenix, Ariz., which it purchased from GTE Corp. in early 1987. Further, companies such as DSC Communications Corp. of Plano, Texas; Tellabs Inc. of Lisle, Ill.; and Rockwell International Corp.'s Telecommunications operation in Dallas; which make multiplexers, cross-connect switches and other types of transmission equipment, all expect good business throughout 1988.

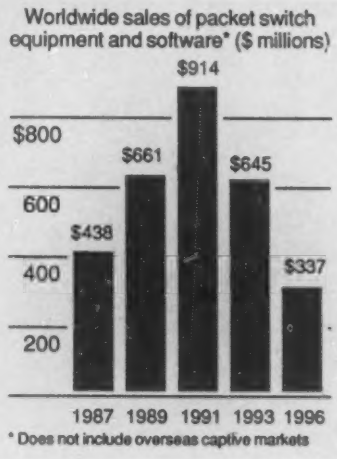
T1 time

"We see strong momentum continuing through the fourth quarter into 1988," says Brian Jackman, vice president for marketing at Tellabs. The headiest segment of the transmission market right now, however, is T1. The term itself comes from a telecom company specification for digital transmission at a rate of 1.5 megabits per second — the equivalent of 24 voice conversations combined into one big pipe. Now, however, it has come to signify a trend among computer users who, having built tens, even hundreds, of in-house local area networks over the past several years, are now linking them via data networks that cross oceans as easily as they cross town.

While T1 had found numerous applications in offices throughout the early '80s, only now is its future significance in the converging voice and data sectors fully being understood. Witness IBM's June agreement with Redwood City, California-based Network Equipment Technologies Inc. for joint development and marketing of T1 technology.

"Suddenly, there was a critical mass [of T1]," says Smith Barney's Sbrilli. "There was enough knowledge and enough of a comfort level at large organizations to go with T1. This is leading to a true convergence where distributed applications processing becomes an integral part of the computer and communications architecture and IBM can't ignore that."

Packet switches will be the big losers as fiber optics proliferate and intelligent ISDNs come on stream



Transmission equipment sales are forecast at 10.4% annual growth rate through 1991, when total industry sales should total $5.8 billion

Neither is IBM ignoring the evolution of the intelligent network. As telecom companies look for ways to distribute more and more intelligence in the network, IBM has signed agreements with Siemens, and L.M. Ericsson Telephone Co. of Sweden to develop interfaces for their respective switches. Meanwhile, it has pursued pacts with United Telecommunications Corp. and MCI Communications Corp., of which it owns 25%, to develop software for the service control points, the network nodes that will contain databases for future advanced services that will be offered by the local exchange companies or private agencies known generically as enhanced service providers.

In the trenches with IBM is Maynard, Mass.-based Digital Equipment Corp., which has been following its own strategy for integrating data and voice in public and private networks. Both computer companies are thrusting into telecommunications in a big way. Their full impact will be brought to bear on the market in 1988 and it is enough to make IRD's Bosomworth hedge when asked about industry growth. "It really depends on if you start defining data-processing equipment as telecommunications equipment," he says.

Yet as the year begins, questions will continue as to how telephone companies will be able to implement future advanced services that an intelligent network would make possible, such as electronic Yellow Pages, voice mail and videotext. The U.S. Justice Department has yet to lift most of the restrictions on the Bell Operating Companies regarding information services contained in the AT&T divestiture settlement.

ISDN needs

ISDN, on the other hand, should move more quickly. This new technology — the ultimate convergence of voice, data, facsimile and video — will see its first-ever commercial deployment in Japan this March. Throughout 1988, ISDN islands, or "concentrations," as Paul Bayliss, vice president for market planning and management of AT&T Network Systems, likes to call them, will appear more and more in the United States. "As ISDN's functionality grows, its need will grow," Bayliss says.

The new technology could spur demand among semiconductor manufacturers as switch manufacturers will require ISDN chips and chip sets. AT&T has already signed an agreement with Motorola Inc.'s Austin, Texas, Semiconductor division for an ISDN integrated circuit that will han-

dle certain network management functions.

The initial cost is expected to be expensive, but then prices are expected to drop. "We're at the start of the learning curve," states Peter Thomas, president of Ericsson Inc., Richardson, Texas, the U.S. subsidiary of L.M. Ericsson. "We're still developing custom circuits. As time goes on and volume grows, the cost will drop." Thomas says ICs that cost $25 apiece now could ultimately drop to $1.50.

Questions remain, nonetheless, as to how popular and widespread ISDN will be as it becomes available. Critics say large users have private networks that perform a great amount of ISDN-like functions already. The cost of ISDN services is still unclear. Even as ISDN approaches reality in Japan, Nippon Telegraph & Telephone is unsure how it will package and price it.

The big loser

Through all of this, packet switches appear to be the big loser. While sales growth will continue until 1990, the ubiquity of fiber optics, and the surge in ISDN — which integrates packet network functions — will start to depress the market. According to International Resource Development, the packet switch market will grow from $650 million in 1987 to $1 billion in 1989, then peak at $1.6 billion in 1991. The market would then start downward to $1.56 billion in 1993 and $1.21 billion in 1996.

Questions remain as to how popular and widespread ISDN will be as it becomes available

Fiber-optic technology will also gain at the expense of satellites. A recent study by Technology Futures Inc., Bethesda, Md., done for Martin Marietta Corp., concluded that fiber optic cable has become the primary medium for U.S. long-haul communications, thereby supplanting satellites. In addition, Bell Communications Research Inc., the research and analysis operation owned by the seven Regional Bell Holding Companies, is already investigating the use of fiber for network television transmission, a method that if successful, would further erode demand for satellite transmission capacity. □

BY BRUCE C.P. RAYNER

Distribution: Keeping a watchful eye on OEMs

Prospects for growth are good but many worry about uncertainties on Wall Street and ship-and-debit abuses

Plain and simple, the $7 billion electronics distribution industry is at the mercy of original equipment makers. If original equipment makers (OEMs) suffer, then so do their distributors.

So it comes as no surprise that many of the top distributors became very jumpy this fall when the stock market took a nose dive. The fear is that uncertainty on Wall Street will fuel economic pessimism, bring on a recession and send distributors diving for cover.

This kind of reaction would dash hopes of solid growth for 1988, which many distributors were forecasting. The optimism that had such a firm grip in September continues to relax and a new caution has entered business plans for 1988. The greatest fear is that this somber mood will fuel the self-fulfilling prophesy for an economic downturn.

Most distributors are feeling helpless. "All we can do is react to the marketplace," comments Gordon Marshall, president and chairman of El Monte, California-based distribution company Marshall Industries. However, "if the economy does not turn into a recession, then we will do quite well," he adds. Marshall is forecasting growth in excess of 20% for his company, *if* the recession can be held off through the year.

Charles Smith, senior vice president of Hall-Mark Electronics Inc. in Dallas, shares Marshall's concern about Wall Street. "Business has been pretty strong," he says, "and up until the developments in the financial markets, I was pretty bullish." But while he puts 1987's growth at a healthy 20%, Smith says there is a big question mark hanging over 1988.

A PC-led recovery

Despite the growing uncertainty in the market, Toby Mack, executive vice president of the National Electronic Distributors Association (NEDA), is sticking with his October forecast of 16% revenue growth for 1988. "There is no way to predict the effects [of Black Monday in October]," says Mack, so NEDA is not going to try. Besides, both August and September produced very strong growth in billings, indicating that there is considerable strength in the economy that the Wall Street bears are overlooking.

Usually, the month of September

Profitability: A major worry for distributors

Averages for 13 publicly held distributors, excluding Avnet Inc.

	1st quarter 1987	1986	1985	1984
Sales ($ millions)	$696	$2,569	$2,354	$2,857
Net income ($ millions)	-$2	-$53	-$1	$77
Net profit margin	-0.2%	-1.3%	0.0%	2.7%
Return on equity	-1.3%	-6.1%	0.0%	15.9%

Source: The Chicago Corp.

posts a 4% growth, but in 1987 it rocketed up 9%. Mack attributes this strength to a "PC-led" OEM recovery, coupled with a relaxation of a tight inventory discipline that many companies have maintained over the past year or so. There is some inventory building going on, he says, partly due to increases in production and also as a hedge against expected price increases. Prices of components, including semiconductors, are firming, as fears of shortages spread. So, many OEMs are buying now, says Mack. Because business conditions continued to improve through 1987, NEDA upgraded its annual growth rate for 1987 from 12% to 14%.

Charles Clough, president of Wyle Laboratories, a distributor based in El Segundo, Calif., agrees with Mack that 1987 was a very strong year, and points to Wyle's distribution sales increase of $70 million over 1986 as proof. Quarterly growth of 10% in semiconductors — about 63% of Wyle's distribution business — was attributable to balancing of inventories, increases in prices and an increase in consumption, says Clough. For systems, the growth was based on increases in demand. Unlike his competitors, Clough is optimistic about 1988. He puts Wyle's growth at 26% to 28% in semiconductors, and 33% to 34% in systems.

Pundits agree that the two strongest growth areas in distribution for 1988 will be semiconductors and computer systems. Semiconductor consumption in the U.S. is forecast to grow 20.1% in 1988, the same rate as 1987, according to the Semiconductor Institute of America. But NEDA's Mack says 16% is more in the ball park for distribution sales.

Similarly, the computer systems market, estimated at about $100 billion in total, will be one of distribution's main targets. Even though margins in systems are lower than in components, the sheer size of the market makes it appealing. Pundits expect the distributors' share of the systems market to reach $2 billion in 1988.

Anthony Hamilton, chairman and chief executive of top-ranked Avnet Inc., the New York City-based parent company of Hamilton/Avnet, says 1988 looks pretty good, despite the roller coaster stock market. "We will be ahead by about 33% of the average growth of what NEDA says, because of all the things we have in the mill," says Hamilton. That puts H/A's growth for 1988 up over 21%.

This fall, NEDA forecast 16% revenue growth in 1988, and so far, few distributors are ready to contradict that projection

The programs Hamilton is so confident about are the computer systems division and value-added services. Digital Equipment Corp. is plugging for H/A to do about $500 million in Digital sales by 1990. Also, H/A is hot on the application-specific integrated circuit design trail, particularly gate arrays.

Although ASICs are not for every distributor, H/A is very committed to boosting its business. Hamilton expects to be one of the "select few" who will survive in the market over the long run. Currently, the company is just about at break-even, says Hamilton, although almost every penny is being reinvested.

But tempering his enthusiasm for 1988, Hamilton says that the stock market crash could well have an adverse impact on growth, particularly in computer systems. "We will just have to wait and see how much of an impact the decline has had on the thinking of corporate business executives in the managing of their businesses and their intentions to invest in capital equipment," he says.

But growth is not the only concern on the distributor's mind these days. Competition ranks pretty high too. With the field of "national" distributors growing, the competition gets fiercer and the pressure on the small players grows in intensity. Last September, the industry took one more giant lunge toward maturity, which will reverberate for many years to come.

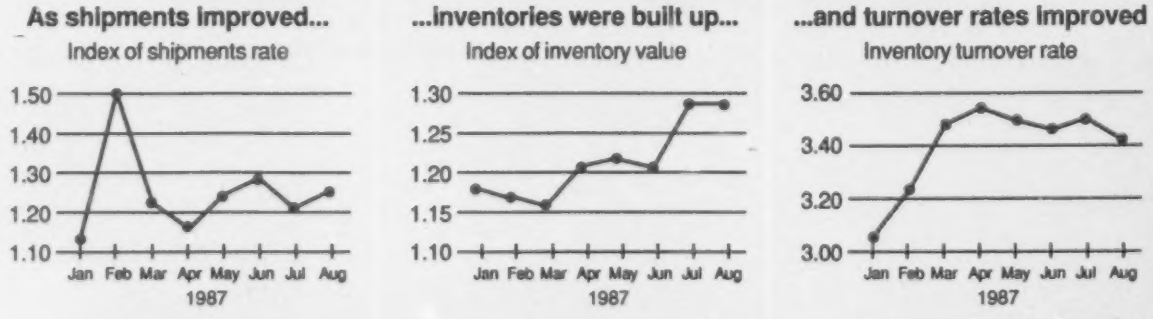
Arrow shoots to kill

That event was Arrow Electronics Inc.'s acquisition of three divisions of its fifth-ranked competitor, Ducommun Inc., including components distributor Kierulff Electronics. Most industry analysts, competitors, customers and suppliers agree that the $130 million purchase was a healthy move for the industry.

The reason it is beneficial, says Robert Throop, chairman and chief executive of Anthem Electronics of San Jose, is that overcapacity and overdistribution are destroying profits. "This long-term dilemma will necessitate the reduction in the number of participants," he says. Ducommun just happens to be the first to go.

Many distributors speculate that

For distributors, 1987 was a year of improvement



Source: National Electronic Distributors Association

since Arrow has now set the precedent, it is just a matter of time before other takeovers or mergers are announced. "The potential does exist for mergers in our business," comments Hamilton, "and it may be that we will have one or two more before the end of 1988." He points to the possibility of "foreign" companies buying into distribution because "distribution is much more respected from outside the U.S. than from inside," he says. Hamilton declined to comment on who those foreign companies might be.

Pundits agree that the two strongest growth areas in distribution for 1988 will be semiconductors and computer systems

On the whole, Hamilton agrees with his peers that the Arrow acquisition was a good move, even though Arrow is now within striking distance of his company. Estimates of the total size of Arrow's sales after the merger range from $600 million to $900 million, depending on how much of both company's sales Arrow will be able to retain. Most analysts speculate that whatever the outcome, one plus one will undoubtedly equal two. Defections of key personnel, as well as customers splitting their business between Arrow and a new competitor, are both factors in this equation.

"It will take a lot of skill on the part of [Arrow's] management to have all branches functioning perfectly after the merger," says Hamilton, "and I can tell you from experience, that an adjustment period is always necessary before true efficiencies are obtained."

Stephen Kaufman, Arrow's president and chief executive, says that the most crucial element in the "adjustment period" will be tying Ducommun into Arrow's in-house computer system. Arrow's technicians have been working on the issue since last September. In his typical upbeat fashion, Kaufman says the in-house computer network will be completed shortly: "We measure it in months, not in quarters, as to how long it will take," he says.

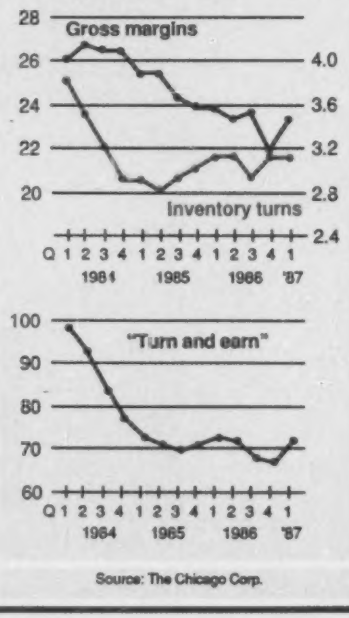
While the next few months will be crucial to Arrow's transition — and to the structure of the industry — there are some very troubling long-term issues that all distributors are being forced to confront. The most fundamental one is the lack of industry profitability. Without a return to profitability in the industry, the ability for distributors to raise equity capital will be dangerously limited, argues Clarke Walser, senior vice president of The Chicago Corp., a market research firm. Equity is the major source of financing for distribution these days.

Walser studied 13 publicly held distributors, excluding Avnet, and found that in aggregate, they had not had a profitable quarter since the second quarter of 1985. The reason can be traced to poor inventory management. Inventory turnover — the measure of how many times a year a distributor sells his stock — has declined from its "normal" level of four times a year to about three times a year for these 13 companies, estimates Walser. Similarly, NEDA reports that its August 1987 inventory turnover rate for its members averaged around 3.43.

Walser claims that while the turnover rate has been dropping, so has the distributor's average gross margin rate. From a high of 26.4% in late 1984, the gross margin of those 13 distributors fell to 21% by late 1986, and is hovering at around 23% today.

The cause of poor profits for distributors: Low inventory turn and declining margins

Aggregates of 14 publicly held distributors, including Avnet Inc.



Source: The Chicago Corp.

Multiplying the gross margin by the turnover rate and by 100, gives the "turn-and-earn" ratio, an index of profitability. Ideally, says Walser, this figure should be over 100, but for electronics distribution, the ratio has been down in the high 60s and low 70s for the past three years. "That is not adequate to produce an acceptable return on investment," says Walser. On the approximately $1.2 billion in total inventory that the distribution industry needs to service its customers, and given a 15% return on investment, profits should be up around $180 million a year, he adds. Second-quarter 1987 profits were a paltry $15 million.

Ship-and-debit debacle

One way the industry can improve its management of inventories is by overhauling the ship-to-stock and debit program. Ship-and-debit, as it is called, allows distributors to sell inventory at below the carrying cost and then debit the supplier for the difference. The original intent of the program was to give quick delivery and good service on large orders. But now it is being used for small orders. The administrative costs of processing the paperwork, coupled with the over-inflated book value of inventories, is depressing gross margins and cutting into distributors' profits.

Hamilton/Avnet's Hamilton calls the state of ship-and-debit "ridiculous" and believes that it is a major area of "profit leak" for the industry. He estimates that "a shocking 80% or more of ship-to-stock and debit is done in areas of $500 line items or less." As a result, "no one makes money," he adds.

While the debate at this stage is reduced to finger-pointing between distributors and their suppliers, there are a few constructive steps being taken. NEDA is formalizing recommendations, including suppliers taking a one-time hit by reducing costs and changing their pricing policies; Arrow Electronics is limiting its ship-and-debit orders to $50, according to an Intel Corp. source; Motorola Inc. is expected to make a stand on its ship-and-debit policy within the next few months; and other distributors are working on direct computer-to-computer links with suppliers, which would eliminate paperwork. □

BY ANNE KNOWLES

Software: IBM casts a bigger shadow in 1988

But with sparkling growth and a $24 billion market, who can complain? Look for OS/2, more Unix and more mergers

While everyone else is warily watching the economy, the software industry may be wallowing in glorious growth. Sales of all types of software — including systems, tools and applications —should jump nearly 23% this year, to $24.4 billion, according to Input, a market research firm in Mountain View, Calif.

While that figure is down from the 35% growth of the software industry's heyday in the mid-1980s, it is well ahead of the computer sector's single-digit advances. Revenue for systems software, which, by Input's definition, includes systems control software, data center management and application development tools, should jump 25.8%, from $9.56 billion last year to $12.03 billion in 1988. Revenue from application packages is forecasted to reach $12.39 billion, up 19.7% from last year's estimated $10.34 billion in sales. These figures, as forecasted by Input, are based on worldwide sales of U.S. hardware and software vendors.

The industry, though, will not entirely escape the economic fallout. Software vendors will have their eyes on the bottom line as much as anyone else. Start-up software companies may have a difficult time raising more equity from venture capitalists, says Harvey L. Poppel, partner at Fort Lee, New Jersey-based merger and acquisition specialist Broadview Associates. Pension funds, which historically provide much of the capital used by venture capitalists, took a beating in last year's market crash. Venture capitalists, in turn, may have few funds to offer young companies. And maturing, privately held companies that had hopes of raising equity through the public market have had to postpone plans of taking their firms public.

Software companies in need of cash, says Poppel, may have one of two choices. "Either they will go out of business or they will have to be acquired," he contends. That may lead to an even bigger boom in mergers and acquisitions in an industry that is already flooded with such deals. In the first nine months of last year, according to W.T. Grimm Inc., a mergers and acquisition firm in Chicago, there were 65 mergers or acquisitions in the computer software supplies and services industry, for a total value of $1.78 billion. Broadview's Poppel believes that buyouts of software companies will accelerate this year beyond the 10% to 20% growth in acquisitions which he had expected, due to the pinch in both private and public funds.

Sales of all types of software should jump nearly 23% this year, to $24.4 billion, well ahead of the computer sector's advances

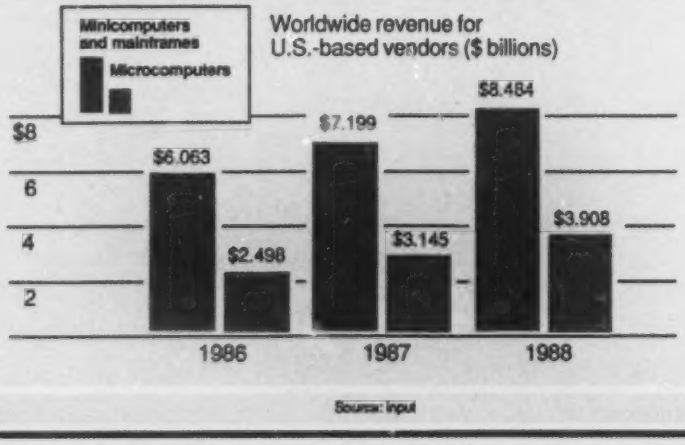
Poppel foresees further globalization of the software industry due, in part, to the acquisition binge. Last year, Broadview participated in a number of deals that involved U.S. and foreign partners. Among the deals was a software unit of Dun & Bradstreet, which was bought by France's Thomson CSF; a British software company which was purchased by Nynex, a U.S. Bell Operating Company; and a $35 million U.S. software firm which was sold to an Australian company.

More overseas sales

Another reason software companies may turn to global markets is the threat of a slowdown in the U.S. economy. Ted Jastremski, a software analyst with market researcher International Data Corp., in Framingham, Mass., contends that this year software companies will begin to increase their foreign sales. Application packages, especially, which have not been sold extensively overseas, will begin to gain more revenue from foreign markets.

However, the software industry, like all other high-tech industries, cannot escape the influence of IBM. The most significant software event in 1988, analysts agree, will be the delivery of OS/2. The new generation microcomputer operating system

Application software sales are growing faster for microcomputers than mainframes and minicomputers



from Microsoft Corp., co-developed with IBM, began customer shipments last month. Two more IBM-proprietary versions of OS/2 will come later in the year. The Standard Edition Revision 1.1, which incorporates IBM's graphics interface derivative of Microsoft's Windows program, called the Presentation Manager, should have initial customer shipments in July. And IBM's OS/2 Extended Version — with the much-awaited proprietary Data Base Manager and Communications Manager — is scheduled for delivery in November.

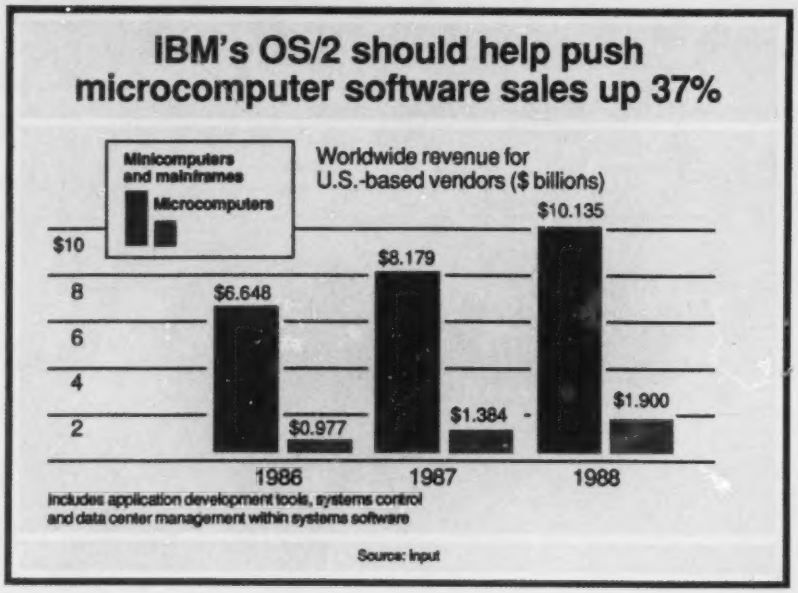
Existing application packages will be rewritten for OS/2 immediately, say most analysts. Companies with popular packages written for MS/DOS, the current operating system for IBM's Personal Computers, will rush to market with identical packages for OS/2, says Mike Cohn, a software industry analyst with Input.

But new applications, written expressly for OS/2, won't start appearing until mid-1989. Cohn says that software vendors are waiting to write for the later editions of OS/2 so they can take advantage of the operating system's graphics, communications and database functions.

"There will be a dramatic increase in networking and applications working together," due to OS/2, said William H. Gates, chairman of Microsoft, at a recent software seminar. Gates also believes that new applications will become increasingly graphic. And S. Jerold Kaplan, founder of Go Corp., a software firm in San Francisco, believes new classes of applications, like Lotus Development Corp.'s recently announced Agenda, will highlight software activity for the next few years. Agenda, developed by Kaplan, former Lotus chairman Mitch Kapor and Lotus R&D vice president Edward Belove, is similiar in purpose to a database, but uses artificial intelligence techniques to help users organize information. "There will be tremendous growth in new applications in the next few years," says Kaplan. "And there is plenty of room for expansion. There is more to life than slugging it out in the word processing, spreadsheet and database markets."

IBM's wrench throwing

Even so, IBM's proprietary Data Base Manager may throw a wrench into the increasingly competitive microcomputer database management system (DBMS) market. Currently dominated by Ashton-Tate, the market is being entered by a number of other DBMS vendors, such as Informix Software Inc. and Oracle Corp. And rumors have it that Lotus and Microsoft, which have never offered DBMS products previously, will also enter the market soon. But Input's Cohn says that in the nine months before IBM's product is available, existing and potential players can entrench themselves in the market. Customers that are not interested in networking their computers will opt for OS/2 Standard Version, without the database engine, thus leaving their DBMS decisions open for competition.



In the first nine months of last year, there were 65 mergers or acquisitions in the software supplies and services industry

Mainframe DBMS vendors, such as Cincom Systems Inc. and Cullinet Software Inc., will introduce database products for mid-range computer systems, an area in which Informix, Oracle and Relational Technology Inc. dominate.

Input's Cohn thinks that other software tools will take off also. Computer-aided software engineering (CASE) products are getting more attention from bigger names. For example, General Electric Co. and Cadre Technologies Inc., a Providence, R. I. CASE company, are developing software together; DBMS supplier Oracle has announced CASE software; and Big Eight accounting firm Arthur Andersen & Co. is offering CASE products. All will lend credibility to the somewhat maligned CASE market, says Cohn.

The fastest growing area of systems software should be data center management, expected to jump 29.8%, to $2.84 billion in 1988, according to Input. IBM dominates the field, but last year's acquisition of Uccel Corp. by Computer Associates Inc., IBM's toughest competition in the market, created the industry's largest independent software vendor. The merged software companies, with a combined 1986 revenue of $407 million, pushed Lotus into second place.

And systems control software, which includes operating systems and networking systems, should reach $5.092 billion this year, up 29.4% from last year, estimates Input.

OS/2 helps Unix

OS/2 may indirectly give the Unix marketplace a push. Paul Cubbage, an industry analyst with Dataquest Inc., in San Jose, thinks that while vendors convert existing packages to OS/2, they will also bring out the same packages for Unix. In addition, vendors will offer MS/DOS running under Unix, before OS/2 arrives. Already, says Cubbage, IBM and Prime Computer Corp., the Natick, Mass., minicomputer maker, have announced products that merge the two operating systems, allowing users to

utilize 32-bit microcomputers as multiuser machines. "It will expand the base of Unix applications, especially those applications that have been popular in the PC world," says Cubbage.

And the issue of Unix standards may finally be put to rest this summer when the IEEE (Institute of Electrical and Electronic Engineers) POSIX standard for Unix is published. X-Open, the European consortium of companies established to promote open architecture standards, is heating up the Unix market across the Atlantic. All in all, Cubbage expects the total Unix market to hit $3.9 billion this year and grow at an annual compound rate of 42%, until 1990, when it will reach an estimated $7 billion.

Big Blue's influence will extend beyond operating systems. The Armonk, N.Y., company's new Applications Software division should start pursuing deals with software vendors this year. The division's immediate intention, stated by vice president Joseph Guglielmi when it was formed last July, is to encourage writers of minicomputer software to develop packages for IBM's 9370 mid-range system. But software vendors have also been wary, afraid that IBM intends to compete directly with them in the applications market. To assuage those fears, IBM has informed its partners of the areas Big Blue will target itself.

IBM will be aggressively trying to protect its software sales, which increased 22% to $4.5 billion in the first nine months of last year

But IBM will be aggressively trying to protect its software sales, which increased 22% to $4.5 billion in the first nine months of last year. While maintenance revenue has declined and hardware sales have stagnated, except in the microcomputer arena, software is the fastest growing area for IBM. And IBM is getting increasingly savvy. "IBM knows they have to play in that market as a software vendor, not a hardware vendor," says Input's Cohn. "1988 will be the bellwether year for IBM's [Applications Software] division. We'll see whether it has an impact on the industry." □

BY PAULA DOE

Materials: Increased prices bring back profit margins

The soft market has kept most materials prices flat since 1984, but all that could change this year

Electronic materials suppliers should finally see double-digit sales growth again in 1988, provided demand remains strong enough to support price increases.

Fabrication materials will see 20% growth in 1988, while sales of packaging materials should climb 25%, according to "Electronic Materials Report," a market newsletter put out by the materials market research firm Rose Associates in Los Altos, Calif. "It will look like a boom year," says Daniel Rose, EMR's publisher. "But in actual fact it's not really all that exciting."

That 20% to 25% growth breaks down into a 10% average increase in volume, combined with a 10% price increase for wafer fabrication materials, and a 15% price increase for packaging materials. "Packaging prices will go up a little more," says Rose, "Because 75% of all packaging comes from Japanese makers, and they are going for a little more because they are trying to recover from the high yen. Volume growth could be as low as 5% if the economy goes flooey."

The soft market has kept most materials prices flat for the past three years. Materials makers see few dramatic increases in yields or major economies from mass production, to bring down their costs. A 10% price increase just about makes up for three years of 3% annual inflation in production costs. What's more, materials makers have had to contend with a recent surge of 20% to 40% in their costs for major raw materials such as gold, silver, aluminum and copper. And customers continue to demand ever purer, more sophisticated materials, which are more expensive to develop and produce, but not necessarily more profitable to sell.

"I have mixed feelings about the move to producing Cadillac devices," notes William Cruickshank, executive vice president for sales and marketing at leadframe maker Shinko Electric America in Santa Clara, Calif. "Making them slows down the whole process, and even when you ship the part, often the customer is not ready to handle it. We charge more for the more complicated devices, but they cost more to make.

Despite advances in new technology, 1988 is still not likely to be the year of the 8-inch silicon wafer

We're not necessarily making more money on them."

"We have to invest in technology to satisfy our customers if we're going to be in this business," adds a spokesman for Monsanto Electronic Materials Co. of Santa Clara. "That takes money, and we're not making it. We're just coming back into breakeven. Our price level is below what it was in 1982."

While there's still a glut of production capacity overall, demand for some sophisticated materials needed for making high-density semiconductors and other advanced devices is expected to exceed supply in 1988, keeping prices up. Makers of electronic materials ranging from silicon wafers and specialty gases to leadframe alloys and ceramic packages, took advantage of strong demands by raising prices 5% to 30% in the final months of 1987.

"There's a difference between leading edge capacity and jelly bean capacity," notes the Monsanto spokesman. "We are going to sop up existing capacity in prime areas." Wafer makers report that the demand for epitaxial wafers, large diameter wafers (above 150mm), and wafers with particularly tight specifications is already

straining capacity.

Monsanto sees double-digit growth and a return to profitability in 1988, thanks in part to its recent price increases of 5% to 20%.

"We expect 12% wafer growth now for 1988," predicts Tad Shimada, vice president and general manager of OTC America Inc., the Santa Clara-based U.S. subsidiary of the Japanese wafer maker Osaka Titanium Corp. "Prices are also going up from now." He notes that wafer prices in Japan are already 20% to 90% higher than in the U.S. because of stricter user requirements and a lack of exchange rate problems. OTC's production of epitaxial wafers is running at 90% capacity. While the company is readying new facilities to double that epi capacity early this year, it is having some trouble finding enough qualified people in rural Kyushu to replace the 150 it laid off last year.

Added silicon capacity

What about that rush of new Japanese silicon wafer capacity? "I think we're safe for two more years," says Shimada. New entrants like Nippon Steel are said to be having problems with yield and have yet to get big volume orders. Established Japanese wafer makers, however, are already adding more capacity in key areas. Besides OTC, Komatsu Electronic Metals and Toshiba Ceramics are also adding wafer production facilities.

Even so, 1988 will probably not be the year of the 8-inch silicon wafer. OTC, which sold the big wafers in sample quantities to IBM, NEC Corp. and Fujitsu Ltd. last year, reports these big users have stopped buying. They aren't likely to start again until a massive demand for some product allows producers to take advantage of the higher yields of the big wafers.

Fabrication materials will see 20% growth in 1988, while sales of packaging materials should climb 25%. Only 10% of this growth is due to volume increases

But as it turns out, 1988 may be the year in which materials for packaging for surface-mounted devices finally take off. EMR projects that by the end of 1988, SMT leadframes will account for 20% of all leadframes used by U.S. semiconductor makers in the U.S. and in their Asian assembly plants. This figure is up from 10% at the end of 1987. EMR sees SMT frames reaching 32% of all leadframes by 1990.

Demand is also pushing at the limits of leadframe makers' current capacity to supply etched leadframes, the fine line devices favored for high pin count, and small volume devices such as sophisticated application-specific integrated circuits.

"We see about 10% increase in unit volume overall, and prices will stay about the same," predicts Michael Lamble, U.S. marketing and sales manager for International Leadframe Corp., the U.S. subsidiary of Mitsui High-Tec Inc. "But there are a lot of new products in etched leadframes — new custom products, low volume, high pin count products —so we may see 20% to 30% growth in etched. That's one of the areas where there are capacity constraints, so lead times will likely stretch out." And, he adds, "SMT is going out of sight."

Over at Koltron Corp., a small producer of etched frames in Sunnyvale, Calif., national sales manager Joseph Herriges asserts that a shortage of industry capacity to etch fine pitch leadframes for the ASIC market could double prices by mid year. He expects etched frames' share of the total leadframe market to climb from the current 5% to 10% in three years. "By 1989," adds Herriges, "almost all we do will be SMT."

"We see near-term continued growth in SMT, quads, and small outlines," says Shinko's Cruickshank. "Maybe 20%. The limiting factor is capacity. Our factory in Japan is all booked up." Shinko reports no expansion plans, although it is adding more equipment at its Manteca, Calif., plant. □

The worldwide wafer fabrication materials market could grow 20%

($ millions)

	1988	1989	1990
Silicon wafers	$1,600	$1,824	$2,152
Other substrates	189	215	254
Photomasks	995	1,134	1,338
Photoresists			
Positive	125	142	167
Negative	86	98	116
Advanced	6	7	8
Wet chemicals	379	431	508
Gases	519	591	697
Deposition materials	203	231	272
Total	$4,102	$4,673	$5,512

Price increase added to unit increase of 10% in 1988 only

Source: Electronic Materials Report

Packaging materials up 25% as Japanese make up for the rise in yen

($ millions)

	1988	1989	1990
Leadframes	$970	$1,077	$1,164
Ceramic packages (metallized)	665	742	833
Thick film pastes	220	242	268
Encapsulation resins	412	493	616
Bonding wire	310	361	432
Sidebrip	384	389	417
Headers and cans	113	117	120
Seal lids	177	203	235
Hybrid substrates (active)	100	110	122
Hybrid packages	115	127	139
Die attach materials	74	84	97
Other	175	210	247
Total	$3,715	$4,155	$4,690

Price increase added to unit increase of 10% to reflect precious metal price increase in 1988

Source: Electronic Materials Report

BY JACK GEE

Europe: Vendors prepare for sustained growth

From chips to computers to communications, most vendors are hoping 1988 will be a year of expansion

Despite uncertainties about economic growth in the West, the continent's electronics industry is preparing for what they hope will be a prosperous year in 1988.

"We are targeting another double-digit increase in profits over the next 12 months," says Klaus Luft, chairman of West Germany's Nixdorf Computer AG. At Alcatel, the French-managed telecom group which now ranks in second place worldwide behind AT&T, president Pierre Suard comments: "Barring unforeseen hitches, the outlook for European electronics is favorable."

Orders for semiconductor devices, a reliable yardstick for measuring the industry's growth rate, confirm this mood of optimism. Sales of 1-megabit dynamic RAM chips are booming as computer and telecom manufacturers compete for limited supplies.

In response to this demand, full-scale production of DRAMs will begin this year at plants operated in West Germany by Siemens AG at Regensburg; in Scotland, by Motorola Inc. at East Kilbride and by NEC Corp. at Livingston. This "Silicon Glen" is also home to a plant where Compaq Computer Corp. is about to start manufacturing personal computers. N.V. Philips GL plans to begin producing 1-megabit static RAMs at Nijmegen in the Netherlands.

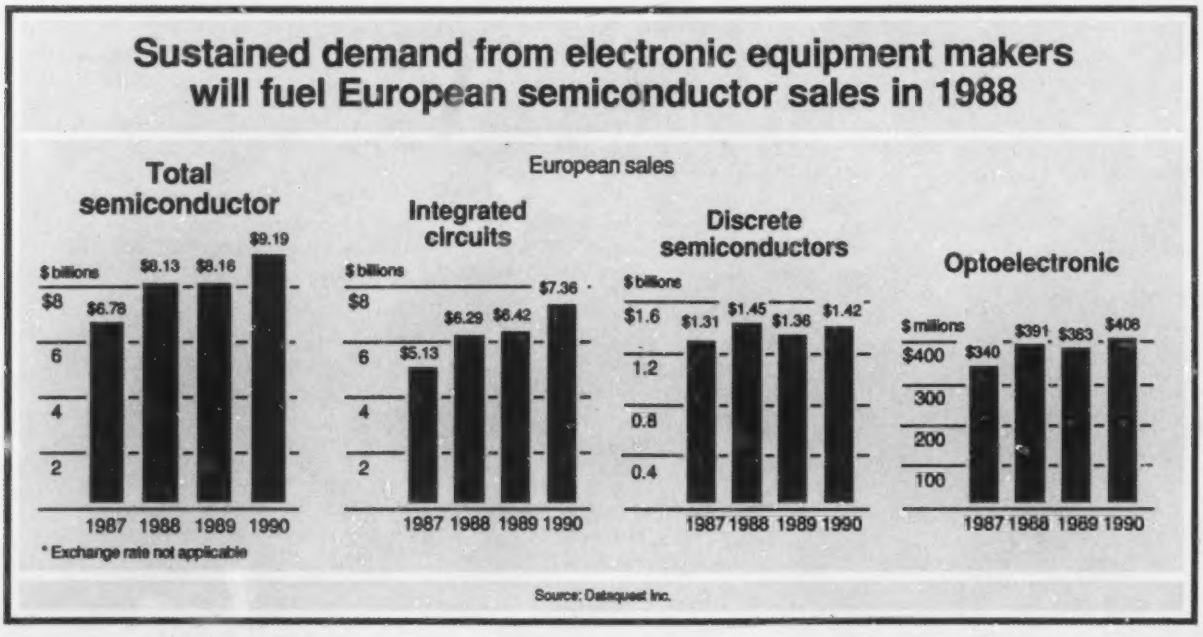
Dataquest Inc., a San Jose electronics market study group, predicts that European sales of 1-megabit DRAMs will rise from 2 million units in 1987 to 20 million units in 1988. As volume shipments of the powerful new chips get underway, sales of 256 kilobit memories are expected to drop from 100 million units to below 60 million units.

According to Dataquest, semiconductor sales in Europe last year grew by 7% reckoned in local currencies and by 23% in dollars. But James Beveridge, director of the research firm's Western Europe Semiconductor Industry Service, says: "Sustained demand in Britain, France and Italy has contrasted with flagging orders in West Germany. Growing unemployment and the high exchange rate for the yen have weakened chip sales in the Federal Republic."

Beveridge believes the upheaval on the world's financial markets is unlikely to prod European consumers into cutting back on purchases of electronic products. "In the U.S.," he says, "there has been concern that the Wall Street crisis will reduce disposable incomes. However, Europeans don't rely as much as Americans on equity revenue for their spending money. Europe can look forward to sustained growth of both electronic systems and domestic products in 1988. And that will be good news for the chip industry." There are also no immediate signs that the stock exchange confusion has prompted chip makers to make immediate cutbacks in capital investment.

Printer production

Europe's chip makers stand to gain from the repercussions of an anti-dumping suit which the 12-nation European Community has launched against Japanese printer manufacturers. To counter the risk of a boycott against their products, the Japanese are beginning to boost their produc-



tion capacity in Europe. This year, Oki Electric Industry Company Ltd. will begin manufacturing at Cumbernauld in Scotland. "And that is another shot in the arm for the European electronics industry, including the makers of the chips which Oki will buy locally," says Dataquest's Beveridge.

Japan is currently shipping into Europe 70% of the printers that it sells there. But Al Stegsteel, a Dataquest vice president and director of its Western Europe Printer Industry Service, says: "By 1990, 70% of those printers will be made by the Japanese at European plants."

Dataquest forecasts that, over the next five years, European market growth will exceed 50% for 32-bit personal computers; 30% for digital telecommunications; 60% for the microprocessor-memory "smart" card; 26% for cellular radio; and 10% for automotive electronic components. "All these markets will begin ramping up in 1988," Beveridge predicts.

But this bullish attitude by Europe's chip sellers and users does not mean that the development of its semiconductor industry will be a painless process. Pasquale Pistorio, the Italian industry veteran, faces the grim task of axing jobs and closing plants as he welds his old company, SGS Microelettronica SpA, with Thomson Semiconducteurs, France's leading chip maker, into the newly created SGS-Thomson Microelectronics group. "This marriage is the only way to create a competitive European semiconductor industry," he says. "With current joint annual sales of $800 million, Thomson and SGS together could soon join the $1 billion league." Already, the new company ranks No. 2 in Europe behind Philips.

The U.S. electronics industry will be tracking Pistorio with particular vigilance as he ponders one tough choice. The new Franco-Italian group has inherited two Stateside plants, Thomson-Mostek's older generation facility and a brand new, but empty, SGS plant. Since the chip business moved into the doldrums, Pistorio has hesitated to equip this Phoenix, Ariz., facility with production gear for micron-width devices. Industry watchers are betting that he will close down one of his U.S. factories. Whichever his choice, it will cause much heart rending.

The coming year will also be a testing time for Europe's telecommunications firms which, in 1987, joined forces in a series of alliances to challenge their U.S. rivals. Indeed, at long last, it is fair to speak of a European telecom industry rather than a disparate medley of small manufacturers which, until recently, depended almost entirely on protected home markets for sales.

To confront AT&T, which has gone into harness with Philips' to market its central office switches, Alcatel, the French telecommunications equipment group, pulled off a $1.3 billion deal in 1987 to acquire most of the European activities of ITT. AT&T tried to recoup by bidding against Siemens for Compagnie Générale de Constructions Téléphoniques, an ailing French switch maker. Eager not to antagonize either the United States or West German governments, the French decided to sell CGCT to a partnership between its own state-controlled Matra group and Sweden's L.M. Ericsson.

In Italy, negotiations toward a joint venture between the country's two leading equipment manufacturers, Italtel and Fiat's Telettra, broke down in November after Fiat refused to accept Italtel's president, Marisa Bellisario, as chief executive officer of the combined operation. The negotiations, which had lasted for two years, were intended to pool the two companies' telecom businesses into a single operation called Telit.

Germany's Siemens, among other

Home is where the PC is

The past year has been marked by the arrival in the European home of the personal computer which, until recently, had been confined to the office.

"When the Sinclair home computers took the market by storm they were clearly designed for hobbyists," says Gordon Curran, joint founder and managing director of Intelligent Electronics Europe, a research company recently acquired by Dataquest Inc. "But nobody seems to be clear what role the PC is going to fill in the family drawing room. It's certainly not child's play to operate a desktop computer —particularly when professional motivation is absent."

The current surge in PC sales in Europe owes much to Alan Sugar, chairman of Britain's Amstrad Plc, who has made a spectacular entry into his local markets with a family of low-priced MS/DOS models. Sugar hoped to sell 700,000 of them in 1987. But sales lagged at around 250,000. However, Amstrad has now squeezed Ing. C. Olivetti & Co. out of second place behind IBM in the European market, according to Intelligent Electronics.

Sales of PCs in Europe grew by 40% to 2.6 million units last year from 1.8 million units in 1986. Curran, who predicts growth for 1988 of 27%, attaining 3.3 million units, says: "Amstrad has stimulated this new wave of interest in personal computers."

A change in retailing methods accompanies this boom in European PC sales. The desktop machines, until recently marketed by specialized stores, are now increasingly sold through mass merchandise outlets. Curran says: "In 1986, the type of shops that sell radio and hi-fi systems accounted for only 7% of Europe's PC sales. But last year, they sold 18% and, in 1988, it is likely they will handle 25%."

IBM, which supplied 25% of Europe's PCs in 1986, has maintained this share of the expanding overall market. Large businesses are gobbling up its new Personal System/2 range machines as fast as they come out of the factory at Greenock, Scotland. Thanks mainly to the PS/2, IBM's share of big account business for PCs which dropped from almost 60% of the European market in 1985 to 40% in 1986, rose to almost 50% again last year, according to Intelligent Electronics' estimates.

Although it has slipped into third place in Europe's PC stakes, Olivetti seems well positioned to move up from being a box producer to the role of systems supplier. This new strategy has been signalled by its recent introduction of a promising range of minicomputers. Curran says: "In 1988, we shall be looking at a much more professional Olivetti."

Like Olivetti, Nixdorf Computer AG is steadily consolidating its presence in the European market by offering both minis and micros. □

companies, had expressed interest in membership. Luis Solana, president of Telefónica, the Spanish national telephone carrier, was also enthusiastic to sign on. Solana had said that Telit "could be the first genuine European effort in telecommunications." The disruption in negotiations is considered by industry watchers to be a major setback in Italy's efforts to pull its communications industry together.

The mushrooming of more powerful industrial groups could be a golden opportunity for Europe's telecom industry. Another big chance lies in Integrated Systems Digital Network (ISDN), the technology that allows data, pictures and print to be transmitted like ordinary phone conversations over the phone network. But these great expectations will be doomed, unless European governments open their borders to outside suppliers. Only Britain has so far shown any genuine willingness to follow this path.

The watchdog Commission of the European Community is urging its member nations to encourage greater competition in the supply of both equipment and data services. Lip service to this objective will soon have to give way to action. By 1992 the Community has undertaken to sweep away its internal obstacles to trade and create a genuine Common Market of 320 million consumers.

Europe's tortoise-style speed of high-tech product development was condemned recently by Jacques Stern, chairman of Groupe Bull, the French computer group, at a conference on Esprit, the European Community's program of research in information technology. Recalling that the high-tech gap between Europe and its Japanese and U.S. rivals remains as wide as ever, Stern said: "European industry is virtually a nonstarter in supercomputers, microprocessors and computer storage devices."

The veteran manager called for research projects to be put under the management of Europe's major electronics companies. Until now, these have been the responsibility of deskbound bureaucrats at the European Community's Brussels headquarters. The appeal by the Bull chairman for a hard-headed, market-oriented approach addresses an urgent issue. But, unless Europe's governments and manufacturers coordinate their efforts, Stern's is likely to remain a voice in the wilderness. □

BY PAULA DOE

The Far East: Beware of the baby dragons

Following in Hong Kong's footsteps, Singapore, South Korea and Taiwan are newly developing Asian powers

Asia's electronics industry will pace world growth again in 1988. As the four dragons — South Korea, Taiwan, Hong Kong and Singapore — prosper, making the things that used to be made in Japan, growth is spilling over into the next tier of less industrialized, lower-wage Asian countries from Malaysia to Thailand.

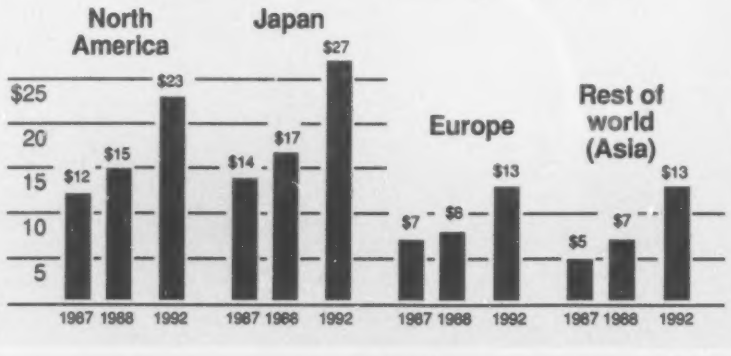
Consumption of semiconductors in Asian countries other than Japan will surge 42% this year, on top of 68% growth in 1987, according to Dataquest Inc. projections. "It's too early to tell what the effect of the stock market crash will be, but even if the U.S. market slows, compared to the U.S., Asia will still do better," claims Tom Wang, who tracks Asian markets for the San Jose market research firm. That means Asian electronics companies, which used a mere $2.9 billion worth of semiconductors in 1986, will use $6.9 billion worth in 1988. By 1992, Dataquest sees a $13 billion Asian semiconductor market — that's as big as the U.S. market in 1987.

Lower stock prices will slow down the Japanese economy too, but 1988 should still be a respectable year. Most producers are starting to see the results of their drastic cost cutting and restructuring to cope with the high yen and are starting to make money again. And domestic demand is finally starting to replace exports in driving economic growth. Dataquest sees 20% growth in Japanese consumption of semiconductors in 1988, after an anemic 1% increase, measured in yen, in 1987. World Semiconductor Trade Statistics Inc. projects Japan's shipments of semiconductors will climb 15.9% in 1988

As more components are used in Asian factories, more will be made there too. "People will be building lots of fabs in Asia in the next few years," points out Wang, ticking off a list of six planned semiconductor

Asian electronics industry will use as many chips as Europe by 1992

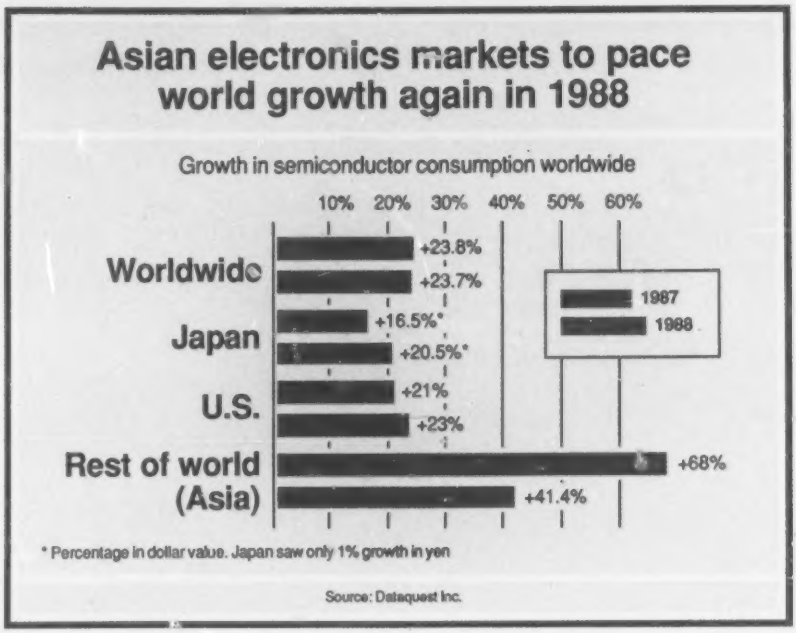
Worldwide consumption of semiconductors ($ billions)



Source: Dataquest Inc.

fabrication plants that come immediately to mind. "There will be lots of opportunity for suppliers of equipment and materials too."

Although a slowing of the U.S. economy could slow the high-speed growth of the Asian electronics export industry, steady long-term growth in the region still means healthy local demand for industrial equipment and business systems throughout Asia. "Before, they didn't care about personal computers," says Wang. "Now that they're rich they want the advanced models."



The Korean card

Korea's plans to upgrade its financial sector, for example, will mean major computer purchases, as will its $400 million program to computerize government agencies. A plan to start computer education in Korean schools in 1989 is expected to spur sales of personal computers. Malaysia has budgeted around $25 million a year for bringing computers to government agencies. A number of countries plan to upgrade their telecommunications systems. "Given their stage of development," notes a government trade official who, like all the trade officials interviewed, prefers not to be identified, "These should be very lucrative markets."

Also spurring Asian electronics growth in 1988 is the rapid expansion of electronics production outside of the four dragons.

The influx of business to Korea, Taiwan, Singapore and Hong Kong has pushed up wages, prices and exchange rates in those areas in recent months. In Korea, wages were up about 20% over 1987. Labor shortages in Singapore are pushing wages for assembly workers up 2% to 4%, and salaries for engineers are up 6% to 8%. The Taiwanese currency has appreciated about 20% against the U.S. dollar.

"These aren't low-wage countries anymore," points out Christopher Mead, editor and publisher of the Southeast Asia High Tech Review in Phoenix. "The per capital income in Hong Kong will be higher than that in its old colonial master, Great Britain, by 1990." Per capita gross domestic income in Taiwan leaped from approximately $3,000 in early 1986 to around $5,000 at the start of 1988.

Korean exchange rates and wages will have to go up too," predicts Mead. "How long can it continue — [with] workers in Korea working just as hard as workers in the U.S., using the same equipment, for $2 an hour?"

Taiwanese electronics producers are now joining the Japanese in fleeing high exchange rates and looking for low-cost assembly labor in Thailand, Malaysia, the Philippines and Indonesia. Thailand's Board of Investment reports 105 Japanese applications for foreign investment in the first half of 1987, twice the number for all of 1986. But now in Taiwan too, every month sees a spate of local producers announcing plans to move production elsewhere in Asia. One recent month saw Sampo Corp. announcing it would make color televisions in Thailand, K T Electronics Corp. announcing it would make loudspeakers in the Philippines, and Rectron Ltd. announcing it would make silicon rectifiers in Malaysia.

This year should also see some Asian markets opening up a little more to U.S. companies.

Lowered trade barriers

Korea removes its import licensing restrictions on computers this year, so users can now buy foreign-made equipment without having to certify that nothing comparable is made in Korea. Tariffs drop from 20% to 25%, down to 15% to 20%. To ensure that the new rules help the United States, as intended, no Japanese personal computers will be allowed. One trade official notes that, "this should make it easier to sell mid-level machines, especially to government agencies, where price is not as big an issue as it is in the private sector."

Indonesia is also opening up its computer industry a bit in an effort to stimulate growth. Government agencies no longer have to buy computers only from the short list of approved vendors. Components can be imported free of tariffs, while import fees on finished products are down to 50% to 60%.

Government trade officials involved in negotiations with Japan expect the Japanese to buy more U.S. supercomputers in 1988. Last August's agreement making the process of purchasing supercomputers more transparent, combined with continued Japanese government pressure on Japanese supercomputer makers to stop drastic discounting, should make it easier for those Japanese institutions interested in buying U.S. supercomputers to do so.

Trade officials are also optimistic about sales of telecommunications equipment to Japan, despite some disappointment in the results of the celebrated telecommunications sector agreement of a few years ago, which was intended to open up the market. Notes one official involved, who prefers not to be identified, "We made regulatory changes that you would expect would lead to increased sales, on paper. But in practice, actual sales have fallen short. What actual sales there have been are probably from the yen appreciation and private efforts, as much as from changes in the rules." □

DATABASE

Recovery still on for computer market

The Federal Reserve Board released its annual revisions to industrial production during the third quarter of 1987. The data from 1985 to the present now reflects the addition of new data not previously available and new seasonal factors. Growth rates were revised downward for most categories of high-tech production. Only computers and office equipment production underwent significant upward revision, from 3.8% to 6.4% in 1985, and from -3.2% to -1.3% in 1986.

In 1987, production dropped off slightly in August from July, but it was still up 6.7% from August 1986. On a seasonally adjusted basis, new orders for computers and office machinery for the month of September were running 8.4% above the same month in 1986 and, at $41.9 billion for the first three quarters combined, were 5% above the comparable period of the prior year.

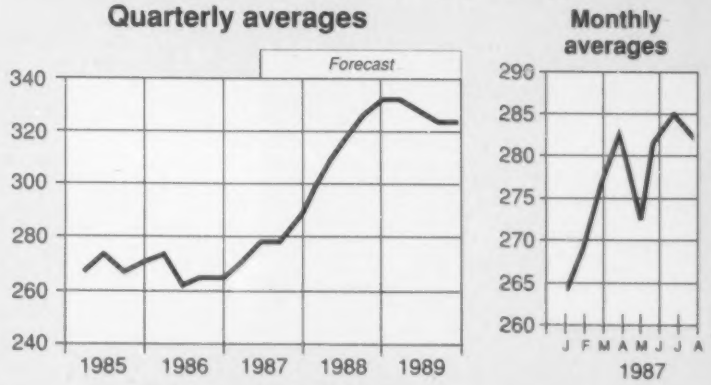
Growth rates for shipments continued to indicate clear signs of improvement. While the values of shipments for the first and second quarters were below the same quarterly levels in 1986, shipments for the third quarter stood at $14.7 billion, an increase of 3.6% compared to the third quarter 1986.

Edited by LINDA STALLMANN

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, MA 02158 Phone: (617) 964-3030.

Industrial production index for computers

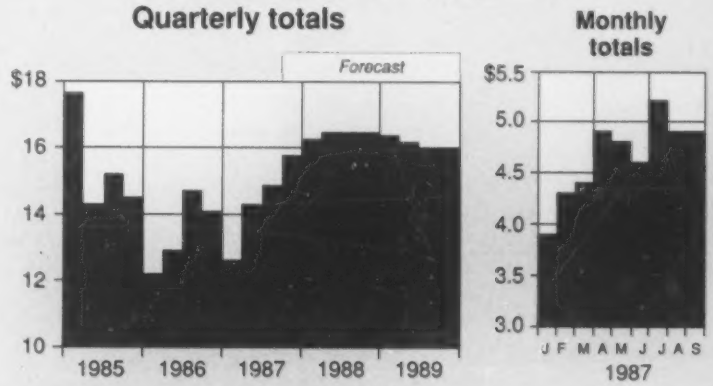
Seasonally adjusted index (1977=100)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

New orders of computers

Seasonally adjusted (Current $ billions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA, 1977=100, August)	283.4	286.4	-1.0%	265.6	+6.7%	328.2	+15.8%
Shipments (SA, $ millions, September)	$4,925	$4,875	+1.0%	$4,703	+4.7%	$5,623	+14.2%
New orders (SA, $ millions, September)	$4,858	$4,857	+0.02%	$4,480	+8.4%	$5,514	+13.5%
Unfilled orders (SA, $ millions, September)	$19,191	$19,258	-0.3%	$19,351	-0.8%	$21,287	+10.9%
Inventory-to-shipment ratio (SA, September)	1.93	1.97	—	2.17	—	1.88	—
All employees (thousands, September)	457.6	458.6	-0.2%	468.6	-2.3%	495.53	+8.3%
Production workers (thousands, September)	151.8	150.8	+0.7%	156.5	-3.0%	162.27	+6.9%
Exports ($ millions, August)	$1,482	$1,422	+4.2%	$1,298	+14.2%	$1,664	+12.3%
Imports ($ millions, August)	$1,589	$1,600	-0.7%	$1,172	+35.6%	$1,711	+7.7%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

SEMICONDUCTORS

4Mb DRAMs: Tough to make; tougher to sell?

The big memory chips promised a 1987 debut. But production and pricing issues make volume sales unlikely before 1989

By Michael R. Leibowitz

In the beginning of 1987, it looked to all the world as if the 4Mb dynamic RAM chip was going to arrive early. At February's International Solid State Circuits Conference (ISSCC), one vendor after another unveiled working 4Mb designs, Japan's Nippon Telephone and Telegraph previewed its 16Mb design, and an IBM presenter announced to a shocked conference audience that his company would be entering 4Mb production during the second half of 1987.

In the months that followed, companies began promising 4Mb DRAM samples by the end of 1987, and the chip makers appeared ready to break a rule that has held for five generations of DRAMs, a rule which says succeeding generations of DRAMs arrive at precise three-year intervals.

Should electronic equipment makers brace for a flood of 4Mb DRAMs in 1988? Probably not. Vendors have pushed out early projections for the new generation part, but more importantly, a number of barriers exist to slow the emergence of the part, rather than accelerate it. "1988 will be a showcase year," where vendors posture and parade their samples before customers, says Victor Dedios, an analyst with Dataquest Inc. in San Jose. Look, instead, toward 1989 as the year that the 4Mb DRAM hits the streets as a production part.

Virtually all of the current DRAM makers have joined the race to produce 4Mb parts. American DRAM makers Micron Technology Inc. and Texas Instruments Inc., and Japanese firms including Fujitsu Ltd., Hitachi Ltd., Matsushita Electric Industrial Co., Mitsubishi Electric Corp., NEC Corp., Oki Electric Industry Company Ltd. and Toshiba Ltd., each have active 4Mb development programs and most have produced working samples in the laboratory. Furthermore, some of these chip makers will have the capability — if they choose — to make production quantities of the part during the second half of 1988.

THE MARKET

But the question of how fast vendors will ramp up the 4Mb DRAM depends more on business and economic issues than on the availability of technology and the headlong dash to grab market share. The losses suffered by companies during 1984 through 1986 have instilled a profit consciousness in the minds of many DRAM players. And in those where it hasn't, fair market value (FMV) controls — which assign minimum cost-based prices for DRAMs — should prevent frenzied grabs at market share and force all chip makers to play the DRAM game more rationally and profitably.

Making DRAMs has become an incredibly expensive business as R&D and capital equipment costs skyrocket with each new generation of part. Chip makers face a considerable investment in order to enter production on the 4Mb — on submicron equipment at $1 million per machine; on new ultra-clean facilities; and on a potentially difficult ramp-up to get suitable yields.

Meanwhile, success in the DRAM business means progressing down the 4Mb production learning curve early and introducing the part while it can still fetch handsome prices on the market. But increasingly, it also means not obsoleting a highly profitable part before its time. And today, the profitable part in question is the 1Mb DRAM.

Chip makers are finally starting to make money on the 1Mb DRAM, and many chip makers are understandably reluctant to interrupt the performance of a part which is finally paying off its capital investment, contributing to profits, and making some company executives glad that they are still in the DRAM market.

Where does that leave the ramp up of the 4Mb DRAM? "It's a compli-

1988 will be the "showcase" year for 4Mb DRAMs; after that, users will start to buy

Worldwide unit sales (millions)

Year	Units	Likely users
1988	—	Sampling only
1989	3-4	Technical workstation makers
1990	50	Mainframe computer makers
1991	400	Personal computer makers

Source: Dataquest Inc.

cated question," says Gregory Armstrong, manager of metal oxide semiconductor (MOS) memory development at Texas Instruments Inc. "The whole issue of how the 4Mb plays against the 1Mb is yet to be answered."

A rapid erosion of prices on 1Mb DRAMs could certainly convince chip makers to gear up early on the 4Mb so that they can shift production emphasis to a more lucrative product. But the 1Mb is unlikely to become the subject of a chip war — FMVs prevent that by linking vendors' price reductions to manufacturing cost reductions.

FMVs for the 4Mb DRAM, if established, will also dramatically influence the rate at which the 4Mb makes a full-scale entry into the DRAM market. The absence of FMV controls on the 4Mb could tempt some memory makers to try to gain market share by introducing the part early at low prices. On the other hand, too high an FMV will delay the ramp up of the 4Mb for lack of customers willing to spend $150 or more on the part.

Lawrence Hester, MOS memory marketing manager at Fujitsu Microelectronics, says that Fujitsu is poised to begin production of the 4Mb DRAM in the third quarter of 1988. "Whether it's even advisable to do so will depend on what pricing is set by the U.S. government," says Hester.

Although the agreement establishing FMVs covers all DRAM generations after the 64K DRAMs units, it is not yet clear whether the Department of Commerce will assign FMVs to early 4Mb parts.

One of the questions Commerce officials will be trying to answer in determining 4Mb FMV pricing will be what costs to base the new product's price structure on, according to William Krist, vice president of international affairs for the American Electronics Association. U.S. firms like to amortize much of their R&D costs into the early production shipments, while Japanese chip makers tend to distribute the costs to other operations within their vertically integrated companies.

Although it is too early to tell for certain, many experts believe that, if necessary, FMVs will be established for the 4Mb to slow it down. There is much evidence to suggest that 1Mb DRAMs will bring sustained profits for DRAM manufacturers in 1988. And if anything, only a small number of early production 4Mb parts will find their way into the market before 1989.

1989 will see 3 million to 4 million units shipped, according to Dataquest — with most of the shipments skewed toward the second half of the year. 1990 will see 50 million units shipped, with 1991 topping 400 million.

Technical workstation makers, eager to pack the latest performance and density improvements into their machines, will be the earliest users of the 4Mb DRAM, predicts Dataquest's Dedios. Mainframe makers will begin using the chip next, followed by personal computer manufacturers in 1991, when the price per bit of the 4Mb will match that of the 1Mb.

Chip makers say that the access time of the 4Mb, while initially coming in at around 80 nanoseconds (ns), will eventually hover around the 60 ns mark, as they tweak their fabrication processes.

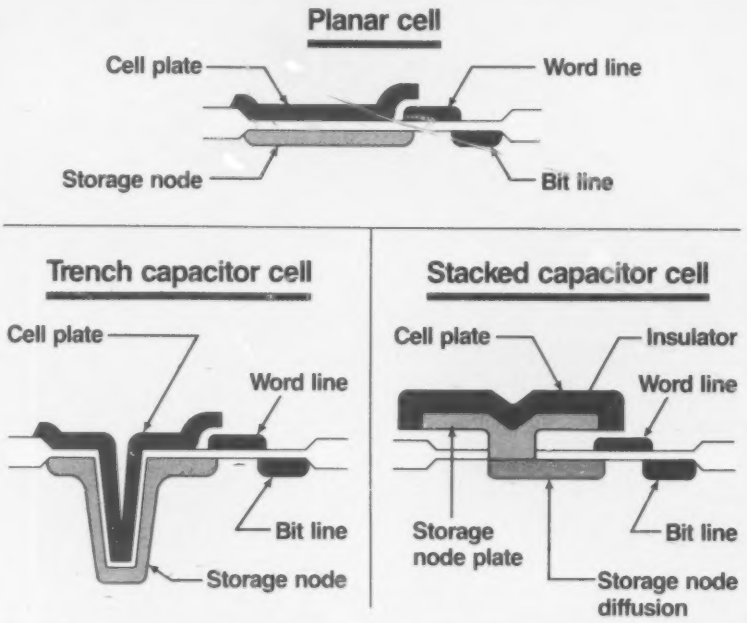
Most chip makers intend to package the 4Mb chip as a drop-in replacement for the 1Mb, in a 300-mil dual in-line package (DIP), 300-mil small outline J-leaded (SOJ), and 350-mil zig-zag in-line package (ZIP). Many manufacturers expect DRAM demand to shift from the DIP to the high-density SOJ and ZIP packages as the 4Mb market grows.

THE TECHNOLOGY

Chip makers face two significant technical challenges in bringing up production of the 4Mb DRAM. One is mastering the art of submicron chip fabrication. The other challenge involves perfecting techniques for

Dynamic memory-cell evolution

In the same way that real estate developers begin building vertically as land prices increase, chip makers have found that building below or above the chip's surface is an effective way to squeeze more memory-cell capacity onto a given die area. As demand for bigger memory chips increases, the older planar design is giving way to three-dimensionnal chip-making techniques. The most popular of these is "trench" technology, already used in 1Mb chips, where a hole is dug into the chip substrate and the walls of the hole are then coated with the charge-storing dielectric material. In the second technique — the stacked cell —the capacitor part is stacked directly on top of the planar cell transistor, still saving space while avoiding the difficult task of building a trench. Both techniques will be essential to fabrication of 4Mb DRAMs. □



Sources: Fujitsu Microelectronics and Texas Instruments

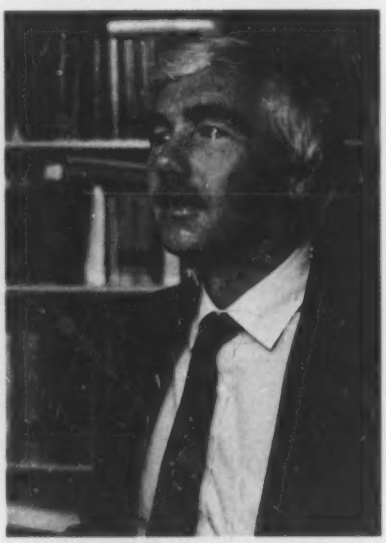
TEXAS INSTRUMENTS' GREGORY ARMSTRONG: Wondering how a fast ramp-up of the 4Mb DRAM would affect successful sales of 1Mb memory chips

building DRAMs using some type of space saving three-dimensional storage element.

Most DRAM makers will be building early production 4Mb parts with minimum transistor gate lengths of between 0.8 and 1 micron. Yields, and hence manufacturing costs, will depend on how well they control line widths and mask registration, and on their ability to reliably deposit multiple levels of metal interconnect materials onto a bumpy chip surface. They will have to master the use of new and sensitive submicron optical stepper-and-repeat imagers, ion implanters, dry-etch gear and chemical vapor deposition equipment. Finally, they will have to understand how to form transistors with the profiles necessary to minimize the destructive effects of hot electrons.

But the real challenge is to avoid increases in so-called "soft error" rates as the chip's features are downsized. On a memory chip, the cell capacitors that store the electrical charge occupy most of the space of the storage cell. Each cell, comprising the capacitor and a transistor element, stores one data bit. And collectively, the storage cells take up 45% of the chip's area. The difficulty lies in shrinking the capacitor's size without lowering the storage charge enough to make it vulnerable to soft errors, where the charge is wiped out by stray radiation particles.

The solution to the problem of reducing the area occupied by the storage cell while keeping its charge constant is to build a three-dimensional cell in place of a conventional planar cell. In the same way that real estate developers begin building vertically as land prices increase, chip makers have found that building below or above the chip's surface is an effective way to squeeze more cell capacity onto a given die area.



FUJITSU's LAWRENCE HESTER: Is poised to begin production of 4Mb DRAMs in the third quarter of 1988

By far, the most popular three-dimensional cell design involves digging a hole into the chip substrate, coating the walls of the hole with a dielectric material and storing charge there. This "trench capacitor" can be dug deeper to increase density, and memory designers believe that it can be used in 16Mb DRAMs as well. While some chip makers attempted to build trench capacitors for their 1Mb DRAM designs, many encountered difficulty in forming the trench and decided to wait for the 4Mb to shift to the newer technology. Two firms, TI and NEC, have been using trench capacitors successfully in 1Mb production DRAMs. Both firms say they will incorporate the cell transistor — the other part of a memory chip's storage cell — into the trench as well, for additional space savings.

The stacked capacitor cell is the other three-dimensional cell design. It stacks a capacitor directly on top of the planar cell transistor, still saving space while avoiding the difficult task of building a trench. Advocates of stacked capacitors say that the design exhibits a slightly lower soft error rate. Critics say that its capacitance is limited and cannot be used beyond the 4Mb density. Users will see little difference between the two designs, however.

Generally, chip makers plan to introduce 4Mb chips in whatever process will allow them to fit the die into

the same 300-mil packages used for the 1Mb models. Later, as their experience with submicron processes and trench cells increases, DRAM builders say they seek cost savings by shrinking their parts to transistor channel lengths of 0.7 micron or 0.8 micron.

COST OF ENTRY

The good news for users of the new mega-memory chips is that the pin layout and package of the 4Mb DRAM is compatible with the 1Mb unit. Equipment makers need only route two extra data lines to their boards' memory arrays in order to drop in 4Mb DRAMs when they become available.

The bad news is that the 4Mb will be very expensive initially. William Shrum, tactical marketing manager at NEC, projects that their price at the end of 1988 will be $150. Other chip makers project even higher price tags.

Prices for the 4Mb will most likely start approaching reasonable levels during the second half of 1989, when many producers begin volume shipments. Dataquest's Dedios pegs their average prices for 1989 at $35, but is reluctant to hazard a guess for 1990. He does believe the 4Mb will reach parity with its 1Mb sibling on a cost-per-bit basis during 1991.

THE COMPETITION

The sampling schedules for the 4Mb DRAM are probably the worst criteria to use for assessing its availability. Each competitor is concerned about appearances and has promised to show samples of technical prowess in 1988, or late 1987 at the earliest. What holds true for chip making in general is particularly relevant to the 4Mb generation: A company's ability to generate samples and ramp up production are two very different things.

Fujitsu, Matsushita, NEC, TI and Toshiba say they will be in production on the 4Mb DRAM by the third or fourth quarters of 1988. For these and other companies attempting early entries into the 4Mb market, factors that may encourage early success include experience in building the big chip's three-dimensional cell capacitor and experience in 4Mb process technology.

TI appears to have a lead in these regards. The company has the benefit of experience in building trench capacitors for its 1Mb DRAM, a factor which should reduce the probability of snafus on its bigger memory part. TI will be trying something new on its 4Mb DRAM, however, by adding a trench *transistor* that will minimize cell area and die size further. But TI is counting on this to lower risks rather than increase them, by allowing the company to fabricate the part on its 1 micron process — the same process used for its 1Mb part — rather than having to bring up a submicron process to achieve the same die size. TI can then move into submicron production on a more relaxed schedule. The company expects to have samples of its 4Mb DRAM in the middle of 1988 and to begin production in the fourth quarter.

Tim Davis

WILLIAM SHRUM, NEC's tactical marketing manager, is projecting a price of $150 for 4Mb DRAMs at the end of 1988

James Caccavo

TOSHIBA AMERICA's JAY LITUS: Hoping that his early lead in Mb DRAMs will help give Toshiba the edge in 4Mb production

NEC also has experience in making trench capacitors for its 1Mb chip. Despite this, the company is taking a conservative approach to the 4Mb business. It is planning two iterations of the part. The first will be a slightly shrunk, 4Mb extension of its 1Mb part, although assembled in larger packages. This nonstandard part should be available in the second half of 1988, according to the company. The second part, packaged in standard 300-mil DIP, 300-mil SOJ and 350-mil ZIPs, will be a total redesign, incorporating a trench transistor along with its trench capacitor and fabricated on a 0.8 micron or finer process.

NEC says that it expects most customers will wait for its second iteration, available at the end of 1989, rather than start early with its larger, nonstandard part. So why are they bringing out the first iteration in the first place? "It's a 'me too' kind of approach," says NEC's Shrum. "No one wants to be the last one out with the 4Mb."

Toshiba's early lead on the 1Mb DRAM may give it production edge

on the 4Mb chip, even though it will be implementing its trench design for the first time. The company is readying a submicron 4Mb part for production in the third quarter of 1988 and will be running the part on the same lines as its 1Mb DRAM, according to Jay Litus, Toshiba America's director of marketing. "The thing that we bring to the party is [an ability] to make it a production reality as soon as possible," says Litus. Toshiba has already produced second-generation working silicon of its 4Mb part.

Motorola expects to manufacture 4Mb DRAMs, but not right away, says Weldon Knape, marketing manager for Motorola's general memory operation. In accordance with its technology and marketing agreement with Toshiba, Motorola will initially package and test Toshiba parts for first shipments in early 1989. The company then expects to bring up its own 4Mb chip production — using Toshiba technology — sometime after that.

Other chip makers claim they are well along in the production process and that they expect no glitches in beginning production on schedule.

THE OBSTACLES

More than two and a half years will have elapsed between the time the first 4Mb DRAM paper was presented at the 1986 ISSCC and when the first production parts hit the market in the back half of 1988. This illustrates how complex this business has become. Never before have DRAM makers faced such harsh economic decisions, technical challenges and regulatory questions in bringing a new product to market.

The actual timing of the 4Mb DRAM will depend on all these issues, although one thing seems almost certain: The big chip will not arrive early. It will, perhaps coincidentally, arrive in the same three-year cycle that has characterized the DRAM business since the advent of the 4K chip. For the 4Mb DRAM, 1988 will look remarkably like 1985 for the 1Mb model. □

Chip makers' 4Mb DRAM schedules

Fujitsu

Samples: 1st quarter 1988
Production: 3rd quarter 1988
Fabrication technology: .7 micron CMOS
Design: Stacked capacitor
Die size: Not available

Hitachi

Samples: 1st quarter 1988
Production: 1st quarter 1989
Fabrication technology: .8 micron CMOS; 2-level metal, 3-level poly
Design: Stacked capacitor
Die size: 232 mils by 606 mils; (140,592 square mils)

Matsushita

Samples: 1st quarter 1988
Production: 3rd quarter 1988
Fabrication technology: .8 micron CMOS
Design: Trench capacitor
Die size: 179 mils by 582 mils; (104,178 square mils)

Micron Technology

Samples: Second-half 1988
Production: 1st quarter 1989
Fabrication technology: .85 micron CMOS
Design: Not decided
Die size: Not available

Mitsubishi

Samples: 1988
Production: 1989
Fabrication technology: Not decided
Design: Not decided
Die size: Not available

Motorola

Samples: 1st half 1989
Production: 1st half 1989
Fabrication technology: Using Toshiba's technology

NEC

Samples:
First iteration: 1st quarter 1988
Second iteration: 3rd quarter-4th quarter 1988
Production:
First iteration: 4th quarter 1988
Second iteration: 4th quarter 1989
Fabrication technology:
First iteration: .9 - 1.0 micron CMOS; 1-level metal, 2-level poly
Second iteration: .8 micron or finer CMOS
Design:
First iteration: Trench capacitor
Second iteration: Trench capacitor; trench transistor
Die size:
First iteration: 244 mils by 630 mils; (153,720 square mils)

Oki Semiconductor

Samples: 4th quarter 1988
Production: 2nd quarter 1989
Fabrication technology: .8 micron CMOS
Design: Stacked capacitor
Die size: Not available

Texas Instruments

Samples: Mid-1988
Production: 4th quarter 1988
Fabrication technology: 1-micron CMOS; 2-level metal, 2-level poly
Design: Trench capacitor; trench transistor
Die size: 200 mils by 623 mils; (124,600 square mils)

Toshiba

Samples: 4th quarter 1987
Production: 3rd quarter 1988
Fabrication technology: Trench capacitor
Design: .8 micron
Die size: 255 mils by 587 mils; (149,685 square mils)

Sources: Company reports

Of electronics ups, downs, leads and lags

U.S. electronics markets lag the economy by a year, and the stock market by even more

By Alberto Socolovsky

I wish more people in the electronics industry had followed Tom Temin's example and had been far away from the newscasts last October 19. The following day, while in the Sinai Peninsula on vacation, Tom visited St. Catherine's monastery at the foot of the mount on which tradition holds that Moses received the Law. Tom, our colleague and chief editor of *Electronics Purchasing* magazine, was briefed there by an English-speaking monk about the stock market crash of Oct. 19. Not that this bit of secular business would affect the good monk's lofty affairs — the monastery has been there before there were any market crashes, and will presumably be there after many more.

Normally, we are thankful when industry executives are around when we call for their opinion on the electronics market. This time, however, a few well-timed and probably also well-deserved vacations would have made our life a lot easier. Or, if the stock market had to crash and they just couldn't follow Tom to a place so shielded from the news, I wish the market had chosen a different date to crash. Late October, you see, is when we canvass industry executives about their opinion on business conditions for the following year. Last October, after the Wall Street crash, it was like trying to detect the Pioneer spacecraft's faint signals during a sunspot storm. Even those who don't believe that there is any connection between the Dow Jones and their business devoted the interviews to explain why they don't believe it.

There is a connection, if for no other reason than that people believe the stock market is important enough to keep it foremost in their minds. But it is important to keep the connection in mind when planning because it is of a long-term nature.

The stock market is one of several leading indicators of the economy. There are others, although they don't get nearly as much publicity. The Cahners Economics department, for example, uses three leading indicators (the Dow Jones Industrial Average, housing starts and interest rates) to build the Cahners Early-Warning Indicator. Those leading indicators bear some relation to what the economy, as measured by the gross domestic product (GDP) will be doing in the future. And, since consumer spending accounts for almost two-thirds of the GDP, the stock market may be telling us today that U.S. consumers may be spending less sometime next year.

This is bad news for manufacturers of consumer electronics products, because the United States is the largest market in the world for these products. According to the Electronic Industries Association, the consumer electronics market here was worth $30 billion last year, and may go up to $32 billion this year. But less than half of these dollars are produced in the United States; most go to manufacturers in the Far East. On the other hand, more than two-thirds of the electronic equipment produced here is commercial. The markets for such equipment lag the GDP by one year. Therefore, what the stock market is telling us now is that business for most U.S. electronics companies may slow down in 1989. That's not as much time as St. Catherine's monastery has, but enough to plan for the slowdown. □

U.S. production of electronic equipment

($ billions)

	1987	1988
Commercial*	$127	$145
Military	52	54
Consumer	16	18
Total	$195	$217

* Communications, computer, industrial, instruments, office and automotive

Source: Henderson Ventures

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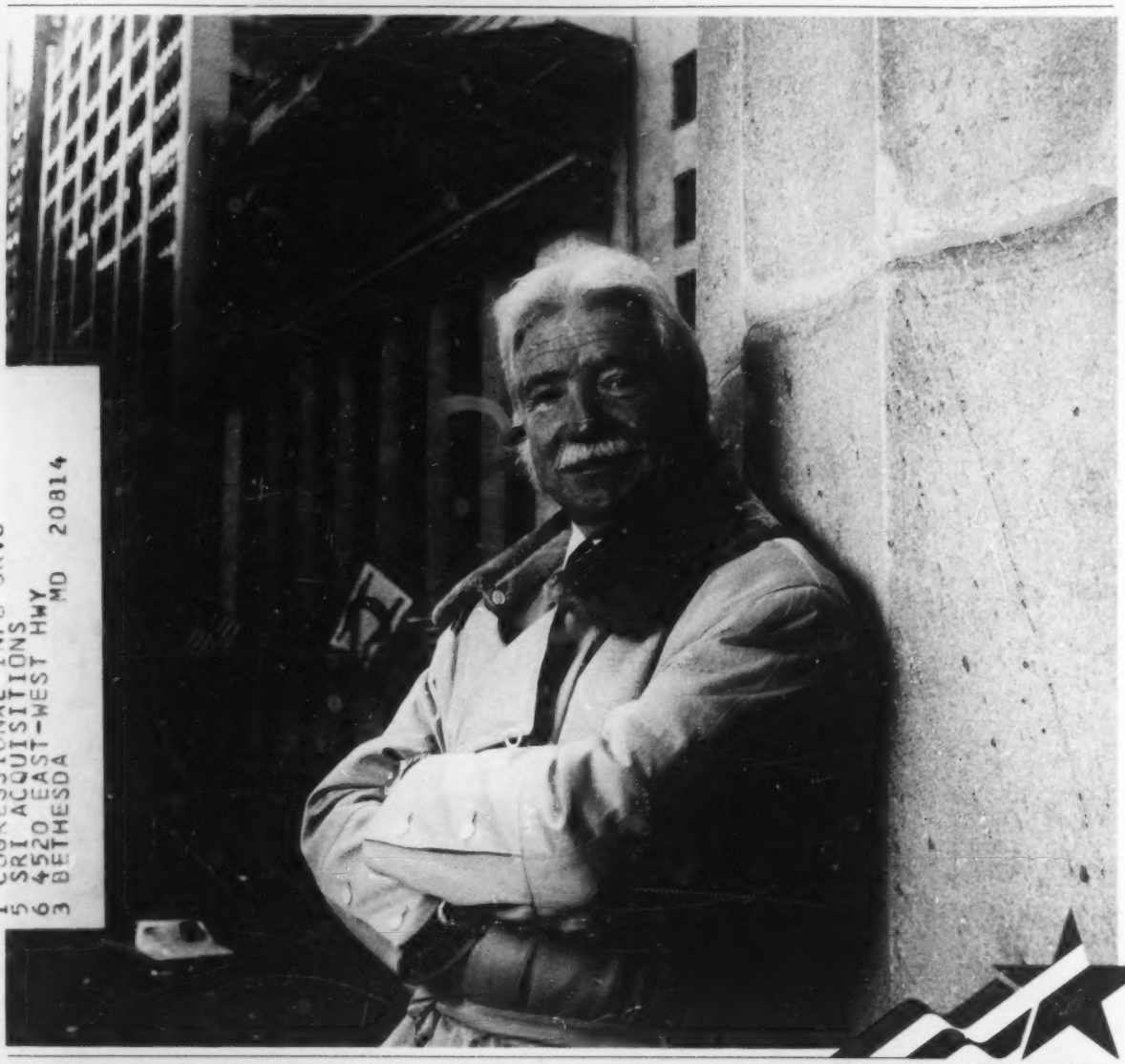
Electronic Business®

Why Intergraph may find it tough to sell chips PAGE 30

From boards to systems: AST's success story PAGE 64



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Keeping America Competitive

VOL. 14, NO. 2

Electronic Business

JANUARY 15, 1988

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES

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Computer companies elbow into telecom international sales

But in the United States, growth for communications equipment vendors still comes from the military

Last October, big users of telecommunications equipment gathered in Geneva, Switzerland, for the Telecom '87 Show, the quadrennial extravaganza organized by the International Telecommunications Union. This is the largest world fair for manufacturers of equipment for data, text, video and telecommunications to show their wares to telecom utilities. Yet the computer companies, rather than telecom, dominated the '87 show.

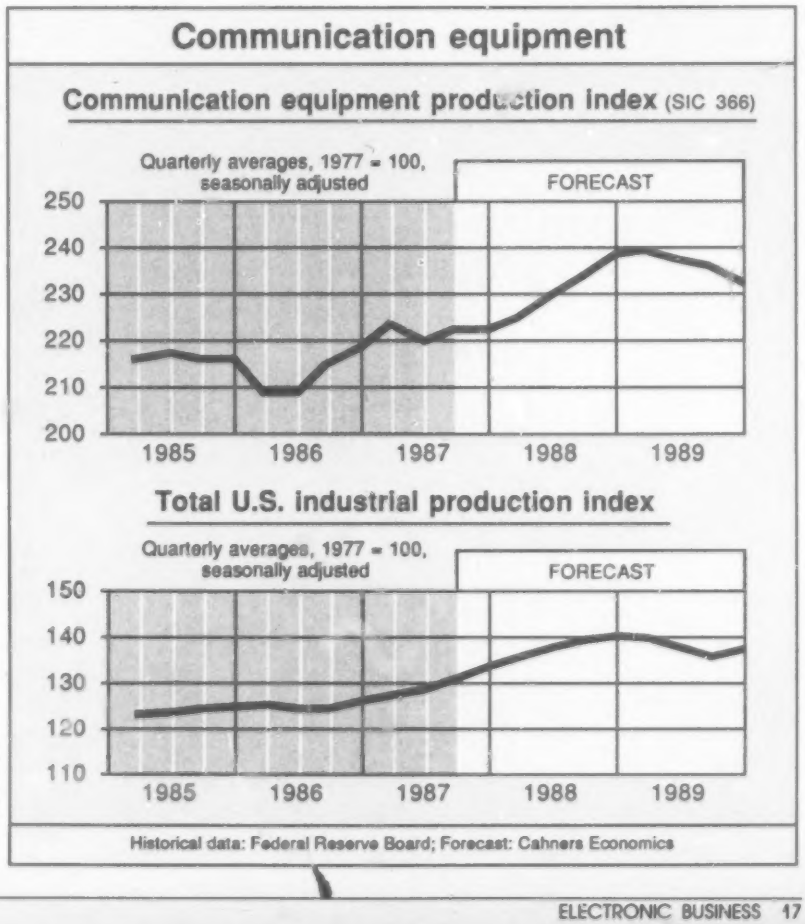
"Fifty percent of the exhibit space was taken by computer vendors," says Tim Mead, chief editor of *Datamation* a Cahners publication. He adds that this figure is "up from 20% in 1983." Mead describes the increase as coming from computer companies which are large, but still smaller than Big Blue. "IBM had a dominant booth at both shows, whereas Digital Equipment Corp. and Unisys had a much bigger presence in '87." Still, in Geneva, IBM loomed over its computer competitors just as it does in the United States, through its subsidiary, Rolm, and through its previous efforts to sell PBXs in Europe, in the telecom market. "IBM must have spent more than $10 million in that booth," remarked an envious exhibits manager of a competitor who spent "only" $1.5 million.

But even a paltry $1.5 million makes an impact. "Every vendor tried his best to show a presence in the international market," observes Penny Blaisdell, general manager for information technologies at ADL Decision Resources, which watches the international telecom market for management consultant Arthur D. Little. Trying its best has paid off for AT&T and Philips Telecommunications (APT), which was a first time exhibitor since its formation as a joint venture three years ago. At Telecom, it announced an impressive series of contracts adding up to $350 million, more than enough to pay for participating in the show.

Most of that $350 million will come from U.S. customers, but not all of the equipment will be built in the United States. In addition to the obvious participation by the giant Dutch manufacturer N.V. Philips, some of the equipment may be built in Spain by Telefónica, which will build a central office equipment factory in partnership with APT.

Indeed, production of telecom equipment in the United States grew a sluggish 4% last year, and Cahners' economist Elizabeth Baatz predicts a similar performance for this year. Yet sales by AT&T, this country's major manufacturer of such equipment, did not grow at all in 1987. Baatz explains that defense communication systems account for almost half of the Federal Reserve Board's industrial production index for communication equipment, and that was the source of growth in 1987. Aydin Corp's sales, for example, which are almost entirely for military communications equipment, increased by 5% last year. But Baatz cautions that the military engine is cooling off, and forecasts that growth in industrial production for communication equipment may crawl to less than 2% by 1989.

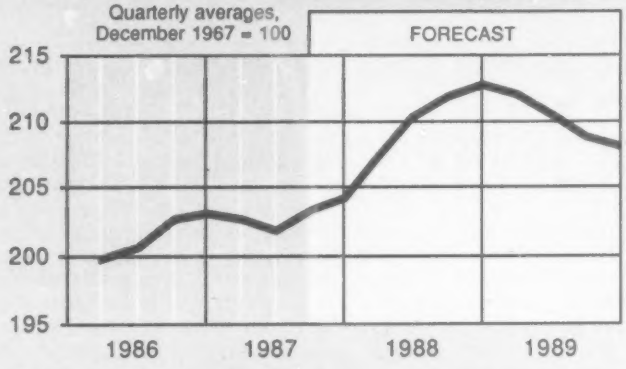
ALBERTO SOCOLOVSKY



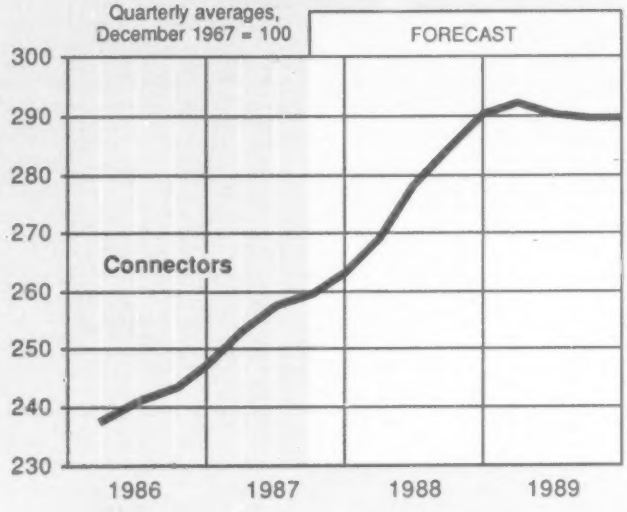
Producer price indexes

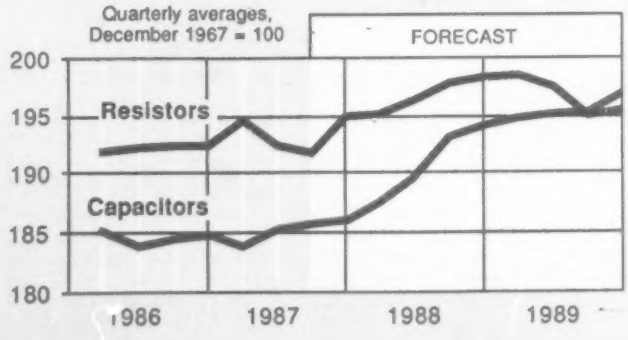
Electronic components and accessories

(SIC 1178)



Passive components





Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic components

Producer prices of all electronic components rose 0.3% in the third quarter of 1987 above year-ago price levels. Prices are expected to pick up another 0.7% in the fourth quarter. By the end of 1987, electronic component prices will have inched up an estimated 0.7%. This is the lowest annual inflation rate for these commodities since 1976. Three factors account for today's low inflation rate: low wage inflation, low interest rates and low commodity prices. This year, these factors are expected to turn around. Component producer prices are likely to grow 3.7% this year.

Capacitors

After five years of falling prices, prices of capacitors rose an estimated 0.6% in 1987. A 0.7% inflation rate in the third quarter (compared with a year ago) and a 0.8% estimated rise in capacitor prices in the fourth quarter accounted for this increase. Rising import prices of Japanese capacitors have been largely responsible for higher prices. Also, domestic factory production of capacitors picked up sharply in 1987, pushing capacity constraints. Further evidence of upward price pressures: leadtimes for capacitors averaged 6.2 weeks in 1987 according to *Electronics Purchasing* magazine's monthly survey, about a half a week longer than in 1986. This year, capacitor prices are expected to rise another 3.1%.

Resistors

Prices of resistors fell 0.5% in the third quarter of 1987 compared with third-quarter 1986 prices, but surged an estimated 1.1% in the fourth quarter. By the end of the year, the inflation rate for resistors had picked up only 0.6%, the weakest annual inflation rate since 1984's deflation. Leadtimes for resistors stretched slightly in 1987, from 4.8 weeks in 1986 to 5.2 weeks in 1987. With commodity prices heating up, expect the producer price index for resistors to rise 1.7% in 1988.

Connectors

Rising demand for circuit boards and rising raw material costs, especially gold, pushed producer prices for connectors up an estimated 6.2% in 1987 and will lead to another 8.5% inflation rate in 1988. These inflation rates are hefty compared with other electronic components and are indeed much larger than connectors' usual inflation rates. Over the past six years, the producer price index for connectors averaged just 2.6% per year. Rising demand and supply pressures have also resulted in a half-week rise in connector leadtimes, up from 6.3 weeks in 1986 to 6.8 weeks in 1987.

To remain competitive tomorrow, firms like AMD must spend big on R&D today — and often risk Wall Street wrath in doing so

R&D

How much is too much?

By Norm Alster

Jerry Sanders has jotted down his latest estimate of calendar 1987 sales for Advanced Micro Devices Inc. The flamboyant chairman of AMD leans forward across his desk in his smartly decorated Beverly Hills, Calif., office. Sanders' sales projection — reflecting the merged businesses of AMD and Monolithic Memories Inc. — comes to $1 billion. But right next to that figure is a far more spectacular figure. Sanders has underlined the number. To its right, he has drawn a giant exclamation point. The figure — $250 million — represents AMD's 1987 expenditures for research and development. "I expect we're going to have sales at $1 billion and we will have spent $250 million on R&D." Blue eyes flashing, gold bracelet gleaming, Sanders pauses for emphasis. "A quarter of a billion dollars," he marvels.

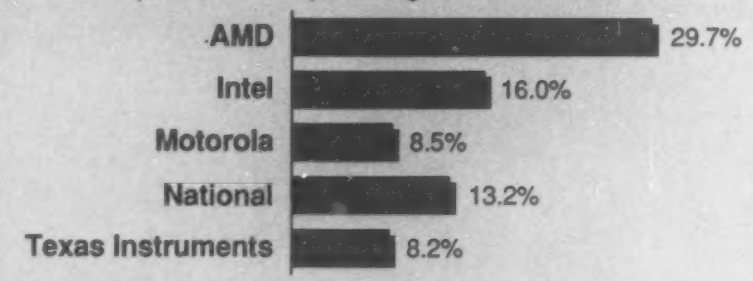
Sanders can be excused his expressions of awe. Although R&D accounting methods do vary between companies, it's safe to say that no other major semiconductor firm has come close to spending as high a percentage of its revenue on research in the last three years. Texas Instruments Inc. and Motorola Inc., for example, have been spending about 8% of revenue on R&D. Intel Corp., R&D runner-up to AMD, has been allocating between 14% and 18% to R&D over the last three years. The semiconductor industry average for fiscal 1986 was 10.6% (ELECTRONIC BUSINESS, Aug. 15, 1987).

And yet, remarkable as AMD's R&D investment level is, it actually represents a flattening off from even higher spending levels in 1985 and 1986. In each of those years, Sanders' firm spent upward of 29 cents out of

AMD's CEO JERRY SANDERS argues that he has spent big on R&D because he has had no choice: "We are spending for survival. . . . To me, the R&D issue is: are we in business or not?"

Wall Street looks beyond earnings in evaluating semiconductor firms

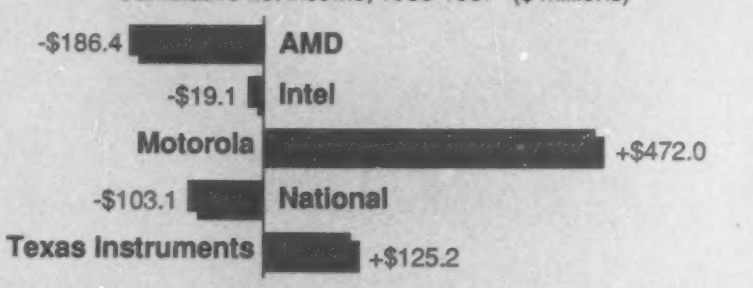
Having outspent its rivals in R&D...



* Totals for National are fiscal 1986-1987 (June 1, 1985 - May 31, 1987)

Source: ELECTRONIC BUSINESS and company reports

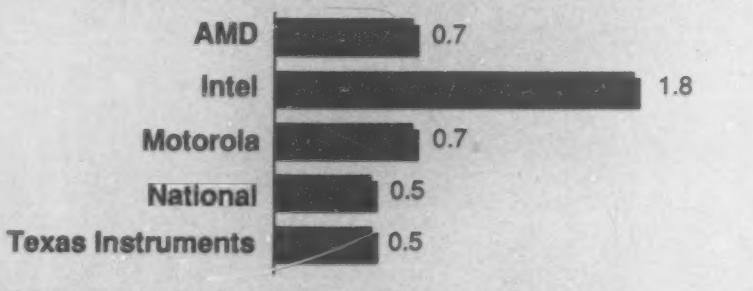
...AMD has the poorest recent earnings history



* Jan. 1, 1985 through Sept. 30, 1987; except National, which is June 1, 1985 through Aug. 31, 1987

Source: Company reports

...but its market valuation trails only Intel's



* Market price as of Nov. 13, 1987 multiplied by number of outstanding company shares

Source: Hambrecht and Quist Inc.

every sales dollar on research.

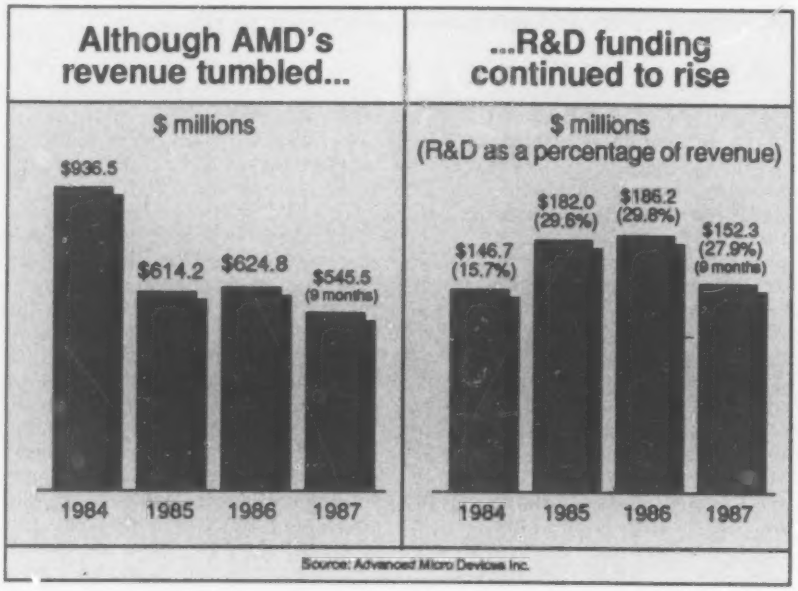
But AMD has paid the price for those outlays, losing money in nine of the last 10 quarters. In the semiconductor recovery year of 1987, AMD was a conspicuous laggard. Wall Street analysts, patient during the downturn of 1985-86, are now getting cranky, demanding some proof that all those dollars haven't just melted away in Bunsen burners. The combination of heavy investment and heavy losses is, after all, the stuff of which management-Wall Street showdowns are made.

Indeed, the AMD situation is beginning to shape up as a classic test case. What happens when an American company persists in sacrificing short-term profits for long-term objectives? No other management question holds more serious implications for U.S. industrial competitiveness. If there is one just and abiding criticism of U.S. executives, it is their focus on the short term and their reluctance (with many notable exceptions) to stand up to Wall Street and make the investments required for long-term competitive strength.

Spend big or spend well?

This is not necessarily a black and white issue. A company can spend big, for example, while not spending well. Some analysts argue that this is AMD's problem. Sanders, after all, overspent to enlarge capacity in 1983 and 1984. In early 1985, high on a cloud of phenomenal growth, he dreamed of making AMD the world's largest semiconductor company by 1990 (ELECTRONIC BUSINESS, Jan. 15, 1985). The company's sales almost immediately thudded back to earth. Were it not for its recent absorption of Monolithic Memories Inc., AMD sales would still be significantly below those of 1984. With AMD unable to capitalize on last year's semiconductor boomlet, some analysts are quite vocal in questioning the prudence of Sanders' heavy investments. "They're throwing mud up against the wall and hoping it will stick," snaps Michael Stark of Robertson, Colman & Stephens, investment bankers in San Francisco. "They've got to retrench a bit in R&D," contends Stark. "They have way too much overhead. A lot of it is R&D overhead."

Patience, patience . . . pleads Sanders. "In the last nine months we have been questioned as to whether or not we're getting an adequate return on our research and development. The analysts who follow the company's



stock are saying: 'You're spending this much money on R&D. What have you got to show for it?' My response to that is: What have you got to show for it during the months of pregnancy? The answer is you don't have much to show for it. You start to show a little bulge in the tummy. But there's nothing aesthetic about that."

Sanders says that he, too, would like to flatten AMD's unsightly little bulge. He has invested at extraordinary levels and now would be content to fund R&D at levels that are merely unusual. Having recently bowed out of static RAM development, Sanders expects to trim 1988 R&D expenditures to $240 million on hoped-for sales of $1.2 billion. Sanders knows he can't go on spending 25 or 30 cents of every dollar of corporate revenue on research. But he's done it for the past three years because he feels he's had no choice. "We are spending on R&D for survival.... To me, the R&D issue is: are we in business or not?"

Not just for you, Jerry, but for the U.S. electronics industry as a whole. Japan's nonmilitary expenditures on R&D now amount to 2.7% of gross national product, well above the 1.7% U.S. spending level. Benefits of that commitment are already evident. The U.S. Patent Office reports that four of the eight leading corporate winners of United States patents are now Japanese. With Hitachi Ltd. and Toshiba Corp. leading the way, the list of top U.S. patent grantees has begun to bear an eerie resemblance to the list of leading dynamic RAM manufacturers.

As such, it may well be that the most serious management challenge for U.S. technology firms is to resist short-term pressures from the financial community in order to make the long-term investments required for survival. The AMD showdown with Wall Street simply refocuses the old long-term versus short-term management dilemma. And since there is new evidence that the long-standing rationale for short-term focus is rooted in errant assumptions, it is worth taking another look at the whole issue.

The combination of heavy investment and heavy losses is the stuff of which management versus Wall Street showdowns are made

A suspect rationale

Any doubt that pressures against long-term planning are both real and powerful should be dispelled by a recent poll of 400 chief executives of U.S. companies, jointly conducted by *Business Week* magazine and Louis Harris & Associates Inc. The chief executives, all from the 1,000 largest corporations in America, were asked: "Industry is criticized for being focused on tomorrow's stock price and next quarter's earnings. Do you agree?" Seventy percent agreed that the criticism was "generally justified."

Pressure comes for a variety of sources — institutional investors, analysts, boards of directors and investment bankers, most notably. It has been argued that such pressures have intensified in recent years because stock ownership has become far more concentrated in the hands of institutional investors such as insurance companies, mutual funds and pension funds. Managers of institutional portfolios are under quarterly pressure themselves to outperform the overall market. They therefore look for companies with favorable short-term earnings prospects to invest in. The problem, says Robert Conrads, managing director and co-head of the technology group for First Boston Corp., a major New York City-based investment banking firm, is that management, to attract institutional investors, often adopts their short-term hor ons.

"I've seen cases where companies go off to either analysts' meetings or go with their institutional investors on road shows and come back from those trips with a specific perception of 'here's what we need to do over the next couple of years to make sure that our stock performs in accordance with our overall corporate performance.' And sometimes that's translated into decisions that affect the quarterly performance that may not be totally in line with what you'd like to see the company do over the long term," explains Conrads.

When management goes out of its way to cultivate the favor of institutional investors and analysts, long-term investments are the most likely casualty. The sacrifice of such investments has always been justified by what appears to be a compelling rationale. Simply summarized, it goes like this: the company that spends heavily on R&D (or other investments, such as capital improvements or expansion of sales, support or service capabilities) will necessarily bring less dollars down to the bottom line. Lower earnings will mean lower stock price since investors will look for a bigger and more immediate bang in more earnings-conscious firms. Depressed stock price will expose the firm to corporate raiders and the threat of hostile takeover. Low stock price will also make it more difficult for the firm to raise capital through equity offerings. The result could be

a capital squeeze since crippled earnings could also result in credit rating lowerings that would make borrowing more expensive. In short, the executive who makes "excessive" long term commitments is putting his company's financial survival, independence (and probably his own job) on the line.

That's the argument. But is any of it true? More and more, the evidence seems to be saying: No.

A recent Securities and Exchange Commission study refutes two linchpins of the argument. Kenneth Lehn, chief economist for the SEC, studied share price reaction to 62 *Wall Street Journal* announcements of new corporate R&D programs. Although such expenditures would naturally depress near-term earnings, the share prices of the companies actually outperformed the rest of the market during the next four weeks. "This evidence strongly refutes the proposition that the stock market values only short-term earnings, and not expected future earnings," Lehn concludes. Ennius Bergsma, head of the corporate finance group at consultancy McKinsey and Co. concurs, characterizing as "a fundamental misconception" the notion that share prices of companies investing in the long term are penalized. Bergsma takes issue with this assumption because it "basically presupposes that capital markets do not understand the value of basic science investment."

Financial fables

Research done at McKinsey also questions the assumption that long-term investment is penalized in share price. Thomas Woodard, a director at McKinsey, says his firm has analyzed market valuations of rapidly growing young technology companies. Woodard says that near-term cash flow prospects generally account for less than 20% of the lofty market valuations of such firms. But 80% or more of their premium valuation is based on an assessment of the company's prospects 10 years out or more. Even for computer companies with sales of $5 billion to $6 billion, says Woodard, long-term prospects account for roughly 60% of market valuation.

The SEC study also lays waste another dangerous myth: that companies which spend lavishly on R&D depress their short-term earnings and share prices to the extent that they become hostile takeover candidates. Lehn analyzed R&D expenditures of 217 target firms in the 1981-84 period. The target firms were actually found to have spent less than half of what nontarget firms in their industries had spent on R&D in the prior three years. "These data strongly suggest that investment in long-term projects such as R&D does not make a firm vulnerable to takeover," Lehn concluded.

But what of AMD? What sort of

Where AMD is spending its R&D dollars

At many semiconductor companies, device designs are the corporate crown jewels. But to a company whose roots are in second-sourcing other people's designs, process technology comes first. "Design is only a small portion of the business," contends Advanced Micro Devices Inc.'s contentious chief executive Jerry Sanders. Sanders, asked to justify his company's lavish R&D budgets, insists that he only spends what he needs to survive. And, he adds: "You cannot survive in this business if you don't have competitive process technology. Competitive process technology is expensive to develop."

But the need for process technology is but part of the reason AMD has had to pour close to 30% of all its revenue back into research in the last three years. AMD's diffused market focus, its late start in CMOS and its problems in meshing design and manufacturing have also played a part.

Despite its relatively modest size, AMD supports costly development in microprocessors, several types of memories, gate arrays, programmable array logic and other basic product groups. Thus, AMD must support research across a broad base of process technologies. Many of these processes are CMOS processes. And here, its late start in the technology has required AMD to invest big to catch up.

Sanders is loath to break out his R&D expenditures. He says only that CMOS process development has cost AMD "an enormous amount of money." And he says development of process technology overall accounts for "25% to 40%" of AMD's research budgets. Key

CMOS process development has cost AMD "an enormous amount of money"

CMOS process technology development is in the following areas: logic; electrically programmable read only memories; electrically erasable programmable array logic; and some specialty logic-intensive memories. There are also development programs in advanced bipolar processes for logic and gate arrays and in BiCMOS (a process combining bipolar and CMOS) for gate arrays. Other areas absorbing broadening streams of R&D cash flow are computer-aided design tools (enabling AMD to create semicustom versions of standard designs) and software (e.g., the assemblers and compilers for the RISC-based 29000 microprocessor).

AMD's ambitious CMOS plans have been slowed by equipment incompatibility between its process development operations (in Sunnyvale, Calif.) and manufacturing operations (in Austin, Texas). Difficulties in dimensional control at linewidths of 1.5 micron and less eventually required the company to update its plasma etch equipment in Austin. Another bottleneck: manufacturing was getting different CMOS processes from different development groups. AMD, says president Anthony Holbrook, has learned a valuable lesson. Manufacturing is now more tightly coupled with development.

Merger motivator

The merger with Monolithic Memories Inc. (interestingly, another big R&D spender, allocating more than 17% of revenue in 1986), allows AMD to eliminate overlapping and parallel efforts. One such example is in high-speed bipolar programmable array logic. The MMI effort has been disbanded, with researchers reassigned to other

stock market penalty has it paid for its spending? Here, the evidence is somewhat equivocal. On the one hand, AMD's share price has declined abruptly from its frothy highs of 1984 and 1985. On the other hand, in spite of that decline and in spite of losses approaching $200 million in the last nine quarters, the market valuation of AMD is the same as or better than those of Motorola, National Semiconductor Corp. and Texas Instruments. The key measure here is market capitalization: the price of a single share of stock multiplied by the total number of outstanding shares. This figure represents the total market valuation of a company. And the market valuation of AMD relative to its sales — while much lower than it was and much lower than that of current industry standout Intel — is (at a recent reading of 0.7) comparable to, or better than, the valuations of its competitors. The market is clearly looking beyond current problems and equating AMD's future prospects with those of its currently profitable peers.

So it appears that the logic invoked to support the short-term focus is suspect at best. But logic is not usually what drives people anyhow. Stock options and bonuses tied to earning and stock price are more powerful human motivations. The simple truth is that shortsighted management is reinforced by the financial incentives in top management contracts.

Mark Edwards, a specialist in executive compensation with Sibson and Co., management consultants in human resources, says "over 95% or virtually 100%" of chief executives in high-technology companies receive either stock options or outright grants of stock as part of their compensation packages. Edwards says that "over 90%" also receive bonuses — typically amounting to 30% to 50% of base salary — if they meet yearly profitability goals. Sanders (who insists he "never worries about stock price") admits to having lost "millions" on his AMD holdings during the October stock massacre. It would certainly take a lot of discipline to ignore those types of swings in net worth. And yet virtually every chief executive has a multimillion dollar stake in the share price and quarterly earnings of his company.

A second factor undermining long-term investment is the growing ascendancy of financial management principles within some firms. The appeal of hurdle rates, cost-benefit analysis, discounted cash flow and return on investment formulas is easy to understand. Such analytic instruments give management decisions a quantitative benediction. But do they make for better decisions? In some cases, excessive reliance on financial mangement tools may actually contribute to poor planning.

Hurdle rates, for example, require investments to yield quantifiable returns. Such economies in R&D are described by Sanders as the No. 2 motivation for the merger. An even stronger motivation was AMD's excess capacity — attractive to MMI at a time when it would have had to expand to meet demand. AMD had suffered from complementary overcapacity, the result of unduly optimistic expansion just prior to the semiconductor recession beginning in 1985. It was this expansion that has undermined much of Sanders' credibility with analysts, who wonder if he's simply repeating his mistake now by pouring dollars down the R&D hatch. Sanders' best hope for proving them wrong is a blockbuster new product.

The RISC-based 32-bit microprocessor, called the Am 29000, figures to be "far and away the biggest blockbuster," according to Holbrook. Although the product was announced in early 1987, AMD still hasn't begun shipments. Sanders insists, though, that the 29000 has generated great interest (particularly for embedded controller applications) and will be a $100 million product in 1989. Notwithstanding the blazing 17 million instructions per second speed that AMD claims for the 29000, many observers doubt that the new microprocessor can carve out that much business. If the 29000 does disappoint commercially, analyst and investor impatience will intensify.

PRESIDENT ANTHONY HOLBROOK says AMD's hefty R&D spending has produced a "blockbuster:" the Am 29000 microprocessor. But the fast 32-bit chip has yet to ship

Sanders himself admits that AMD "should have done a better job than we have in getting some of these new process technologies into production." He also concedes that AMD's R&D program will "have to do some focusing." His immediate goal is a 20% revenue increase in 1988, along with a $10 million R&D cut, that will trim R&D to a more manageable 20% of sales. Does he believe that AMD's enormous outlays will eventually justify themselves? "Absolutely," he replies, predicting that the output from AMD labs in the next five years will be "overwhelming." □

Liane Enkelis

turns of a given level — let's say 15% over a tightly defined period of time. The problem, explains Todd Hixon, vice president with the Boston Consulting Group (BCG), is that high hurdle rates discourage longer term investments. It is difficult for an investment to clear a 15% hurdle rate if it does not begin paying back very quickly. After five years, for example, that invested cash — to clear its hurdle — would already have to be worth twice as much. "It's very difficult for U.S. companies to engage in programs where the payoff is more than two years away," laments Hixon. George Stalk, a director with BCG, says hurdle rates are also dangerous because they are often applied uniformly across business units of large firms. The same return formulas are invoked for radically different types of operations: differences between globally competitive and globally uncontested; between high growth and low growth; between strategic and nonstrategic businesses are overlooked. Oftentimes, argues Stark, investments that must be made for competitive survival are vetoed because of insufficient financial "justification."

McKinsey's Woodard argues that there is a built-in flaw in the way hurdle rates and financial return formulas are commonly applied. If, for example, a company invests $50 million in a factory to build a new product, its returns would be judged against, let's say, a 10-year estimated life. This would be the period over which the investment would be depreciated. In calculating potential returns, many companies would assume that once the plant was fully depreciated, it would no longer have any value. But what if that product has allowed a company to expand its customer base? Even after the plant has been depreciated, the company still realizes the benefits of an enhanced revenue stream and broadened customer base, argues Woodard. Yet residual value does not enter into the calculations of the accountants and financial planners who hold sway at many corporations. The consequence is often an underinvestment — or, in extreme cases, abandonment of — existing businesses. A prominent example of a company that is often inordinately respectful of financial formulas is General Electric Co.

Managing by the numbers

Under former chairman Reginald Jones and current chairman Jack Welch, GE has established itself as a company with a proclivity for managing by the numbers. With financial services now accounting for more than 20% of earnings and with funds generally allocated internally according to fairly rigid financial return formulas, GE now functions more like a bank than a manufacturing or technology company. Says James Alic, a senior vice president for corporate planning with RCA Corp. before its takeover by GE, and subsequently group vice president of entertainment operations until his departure from GE in late 1986: "I think Jack Welch has been pretty clear that businesses that don't earn 15% return on investment are pretty questionable." To find such businesses, Welch has acquired cash cow operations in financial services and defense contracting (through the acquisitions of RCA, Kidder Peabody, Employers Reinsurance Corp. and others). In technology sectors (like aerospace) where profits are relatively easy to come by, GE has invested aggressively. But it has opted for the exit doors in many of the tougher core manufacturing and technology businesses. GE's recent unloading of its consumer electronics operations provides an informative case history.

After its acquisition of RCA (coveted for its broadcasting and military contracting), GE commissioned a study to examine prospects for the the combined GE-RCA consumer electronics business. This was a $3 billion-a-year business that was, according to insiders, operating with modest profitability at the time. Alic was a supervisor of the study, which got under way in early 1986 and involved several major outside consulting firms. Manufacturing, marketing and technology issues in the consumer electronics industry were all analyzed.

The conclusion, according to Alic, was that "it seemed feasible to com-

Fact versus myth: Five financial fallacies that undermine long-term competitiveness

Myth #1: When a company launches major R&D spending programs the price of its stock is likely to go down.

Fact: A Securities and Exchange Commission study found that the stocks of companies announcing such programs actually perform better than the market as a whole over the succeeding four weeks.

Myth #2: Good quarterly earnings is the key to high stock prices.

Fact: Research by McKinsey & Co. establishes that 80% or more of the valuation of high-flyer technology stocks is related to their long-term (10 years or more) outlook.

Myth #3: Companies which spend heavily on R&D are vulnerable to hostile takeover bids.

Fact: Firms targeted for takeover between 1981 and 1984 were found to have spent less than half of what nontarget firms in their industries had spent on R&D during the prior three years.

Myth #4: The paybacks from investment in R&D are chancy and impossible to quantify. You have to do some R&D, but it's too risky to spend heavily.

Fact: A nine-year study of 42 R&D investment programs found that on average they yielded returns of 300%. Depending on how returns were calculated, the annual return on investment (ROI) ranged from 20% to 35%.

Myth #5: Investing for the long term puts a permanent crimp on short-term earnings.

Fact: The average R&D investment begins to pay off in four years. Once a company adopts permanently higher R&D investment levels, it will suffer an earnings penalty — but only for those four years. After that intitial waiting period, the first expenditures start paying off and the company begins to enjoy continuing short-term benefits from its long-term investments.

GE CHAIRMAN JACK WELCH runs a company that is often inordinately respectful of financial formulas. Subordinates say Welch has been clear that businesses that don't earn 15% return on investment are "pretty questionable"

pete in the business." The consensus was that a U.S.-based consumer electronics business was "worth taking a shot at." Another direct participant in the study (who asked not to be identified) says it was felt that with the proper investment and commitment, GE could probably "slug it out" in consumer electronics, making "respectable" profits.

GE was encouraged to slug it out for a basic reason beyond immediate profitability: consumer electronics has significant strategic value. Televisions, video cassette recorders and video cameras are products where sophisticated new electronics technologies are first produced in high volume. Television manufacturers are likely to be the first to apply high-volume production to digital signal processing and flat-panel display technologies. Video cameras have already revolutionized the pricing of photosensors, giving tremendous competitive advantages to their Japanese manufacturers. The Japanese, of course, have benefited repeatedly from introducing advanced electronics into high-volume consumer electronics applications. "I think a Japanese company would have kept it. That's the distinction. The Japanese would have said: 'There are some strategic elements to this.' And there are," reasons the GE insider.

But GE-RCA managers were told they had two years to spruce up the bottom line. "What you saw from the top management at General Electric was the classic 'you've got two years' kind of thing. Besides which, they didn't have a lot of appetite for that kind of business," adds the informed source. In the end, GE would not even give consumer electronics that long, choosing to trade the business to French electronics conglomerate Thomson CSF for its more glamorous, presumably higher-growth medical electronics business. Why slug it out tooth and nail with the Japanese and Koreans in manufacturing when you can sit on fat market share and a head start in technology and simply milk (what for the time being is) a sure thing?

Industry whipping boy

Of course, there is an alternative to management by the numbers. Sanders, in this respect, can take heart because his R&D funding methods closely track those of Digital Equipment Corp., a company he'd do well to emulate.

DEC has been flying high for some time now, but from 1983 to at least mid-1985 the company was the industry whipping boy, regularly rebuked for its poor financial performance and product deficiencies. DEC had a clear choice: It could curry favor with Wall Street by trimming investments, abandoning a no-layoff policy and announcing a shareholder dividend. Or it could accelerate long-term investment, even at the cost of eroded margins.

During these dark days, reports

The most serious challenge for U.S. high-tech firms may be to resist short-term pressures from Wall Street and make the long-term investments needed for survival

Samuel Fuller, DEC's vice president for research and engineering, the company was not funding R&D according to the numbers. "There was a lot of argument inside the company," recalls Fuller. Engineering vice presidents would outline their own future product and technology needs, only to be reined in by financial analysts within DEC invoking return on investment formulas. DEC chairman and chief executive Kenneth Olsen, says Fuller, ensured that the engineering chiefs got a fair hearing. Never mind if their proposals violated financial formulas.

SAMUEL FULLER, DEC'S R&D CHIEF, says DEC chose not to fund R&D according to the numbers. The result of its $3 billion R&D spending was one of the most extraordinary new product blitzes in computer industry history

In the end, Olsen steered DEC toward a consensus for heavy development budgets, even if they temporarily crimped margins. DEC wound up spending $3 billion in research during a four-year period. The result was one of the most extraordinary new product blitzes in computer industry history as DEC trotted out an average of one major new system a month between January 1986 and March 1987 (ELECTRONIC BUSINESS, May 15, 1987). DEC's dramatic turnaround reestablished the Massachusetts giant as the fastest growing multibillion dollar company in the computer industry.

Sanders should also be encouraged by the results of what is to date the most definitive study on the efficacy of R&D. Using data from the Strategic Planning Institute, researchers tracked the investments of 42 U.S. business units over a period of nine years (1971-1979). On average, R&D investments were found to have a payback of 300% over the period (or 20%-35% on an annualized basis), according to David Ravenscraft, an associate professor of business administration at the University of North Carolina at Chapel Hill. The bottom line is that the average investment in research pays off.

Unless Jerry Sanders has made an awful lot of below-average R&D investments, AMD's bottom line should begin to improve. Sanders has done well to spend big. Now he must only prove that he has spent well. □

RichFriedman/Black Star

MICROCOMPUTERS

AST Research: The board maker that is making all systems go

AST's transition to PC-making is working well. But recent profit fizzles prove the firm still has lessons to learn

By Bruce C.P. Rayner

Just what the world needs: another personal computer, right? Well, according to AST Research Inc., that is exactly right: a high-performance machine, aimed at the power user, that will give high-end producers like IBM and Compaq Computer Corp. a run for their money. In spite of some initial rockiness, AST is showing signs of having what it takes to be a serious contender in the microcomputer systems business.

Already, over half of the Irvine, Calif., firm's sales are from systems. And its hot PCs, unveiled just over a year ago, continue to attract buyers. But the metamorphosis from respected board maker to aspiring systems company is not without headaches. Winded by IBM's introduction of the Personal System/2, AST has had to write down inventory of add-in boards for older PCs. And it must brush up on its distribution techniques and deal with the lower gross margins of the systems business.

AST's three visionary cofounders — Albert Wong, Safi Qureshey and Thomas Yuen, whose first names form the firm's acronym — claim that the transition to systems sales is all part of their long-term plan. They founded AST as a consultancy in 1980, and set about building a company that one day would enter the systems market. In 1983, president Qureshey stated that "in three to five years, we will become a $200 million company with three divisions." The $200 million and the three divisions — boards, datacommunications and PCs — are now a reality. For the fiscal year ending June 30, 1987, AST produced sales of $206 million, with net income of $13 million.

The company's capital base was built by penetrating the interior of the IBM PC. With a series of enhancement boards, AST managed to cap-

James Cacioppo

AST's YUEN, WONG and QURESHEY (left to right) are confident they can put a dent in IBM's armor with their new Premium/386 machine

ture a piece of the PC market and at the same time develop a reputation for quality and service. Board sales rose from $12.78 million for fiscal 1983, to $172 million by 1986, and net income grew from $1.6 million to $27.7 million.

Today, the company boasts that AST's board products account for about 70% of all IBM's third-party service contracts. With the groundwork laid and brand recognition established, AST is now playing both sides of the net. It continues to support IBM products, including the PS/2 products, with its enhancement products — although somewhat late in bringing its products to market — and now it is stepping into the ring with Big Blue as a direct competitor.

By early November, just short of a year after shipping, AST had sold 50,000 units of its IBM PC-compatible Premium/286 machine, and the company is currently ramping up production on its second-generation products: the Premium/386, an IBM PS/2-compatible, and the small footprint AT-compatible Premium workstation. In terms of market share — 0.6% of the United States PC market — AST is still insignificant. But then Rome wasn't built in a day either.

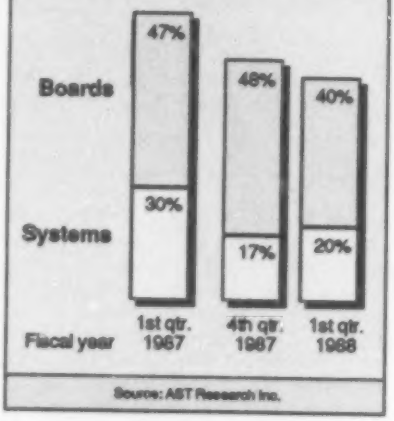
The company is convinced that as more users are turned on to the power of the AST machines for business, CAE/CAD/CAM and desktop publishing applications, their popularity will follow. "We feel that if the user can get their hands on it, they will buy it," claims executive vice president Yuen, the marketing tactician of the founding team. Many users agree.

"AST is going in the right direction," says Julie Irving, corporate personal computer coordinator for Pacific Financial Companies, formerly Pacific Mutual. PFC recently bought 230 Premium/286s and will be buying more in the future, says Irving. Similarly, Robert Holman, director of engineering at Amphenol fiber-optics products division, a part of Allied Amphenol Corp., is favorably impressed with the Premium/286. Holman says the AST machine runs spreadsheets between six and 16 times faster than conventional PC clones and about two to four times faster than an IBM AT.

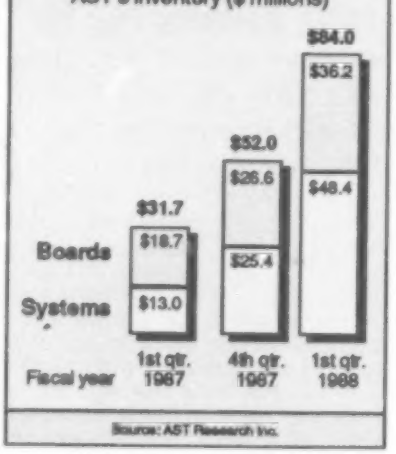
Fickle PC business

AST is not daunted by the fight that lies ahead. But success in the fickle PC business depends on how successfully the company can restructure itself internally; it depends on how it allocates its research and development monies in the future; and it depends on how effectively the company can get its products to market.

AST must learn to deal with the lower margins of the systems business



Hit by IBM: The PS/2's debut has left AST with more inventories than it cares for



The transition began back in 1986 and is winding down now, claims AST's Yuen. The need for restructuring was never doubted, but the perception of AST as a company in turmoil is wrong, he says. With revenue doubling in six months and a product mix going from 80% boards to 60% systems, short-term growing pains were unavoidable. The changes were anything but haphazard. They were "designed," and as a result, the outlook for 1988 is very optimistic, says Yuen. "I think AST's performance will surprise a lot of people, including some of our own skeptics within AST," he adds. He is forecasting the systems market to grow at a 25% clip and for AST to outperform the market.

To ease the growing pains, AST has separated its three product lines into independent divisions. Each has its own senior vice president responsible for the marketing, sales and engineering functions. In addition, there are the corporate divisions which cut across product lines: research and development; worldwide manufacturing; the corporate sales operation that focuses on developing major corporate accounts; and administration.

But independent sources claim that some key issues still have to be resolved in the restructuring. Most notable in those changes is the integration of AST's Apple Computer Inc. enhancement board products into the board division, says Benny Lorenzo, a vice president and AST watcher at L.F. Rothschild, Unterberg, Towbin in New York City. Lorenzo also insists that AST needs to strengthen its control over worldwide manufacturing operations, since improved communications to the Far East facilities are crucial to keeping costs under control.

As far as distribution and marketing of the new systems, AST still has a long way to go. The strategy so far has been to develop a two-tiered selling approach, whereby AST develops corporate leads by offering its systems for an extended trial period to a targeted corporation and then lets a value-added reseller or distributor make the sale.

For resellers that have taken on the AST line, it has proven successful. The Computer Store Inc., a $5.3 million Santa Monica, California-based reseller, has expanded its AST systems business so much in the last eight months that it's now the firm's primary corporate computer, says Bonnie Scott, the reseller's major accounts coordinator. "Acceptance is strong because of brand name recognition," she says.

But the size of AST's distribution network is a major limitation at this time. Even though about 700 resellers carry the systems products, AST has not yet established a corporate-wide franchise with one of the big chains,

such as ComputerLand Corp. or Businessland Inc. There are independent franchise arrangements with some ComputerLand stores, but AST has yet to crack the boardroom of either chain.

While IBM and Compaq are aiming at those retail chains in the top 20% for sales, Yuen has initially targeted the lower 80% of the resellers. But the list also includes some of the most well-respected names in the business: resellers like Micro D Inc., Microamerica Inc. and Tech Data Corp. are selling AST's systems, says Yuen.

But original equipment manufacturer deals — in which the OEM slaps its own name on the AST-made box — are also being considered by AST. Currently, the debate is over how to best penetrate the Japanese market that has traditionally been closed to U.S. personal computer makers, including IBM. AST is considering whether or not to pursue a Japanese OEM to market the AST computers, says Wesley Nelson, vice president for international sales.

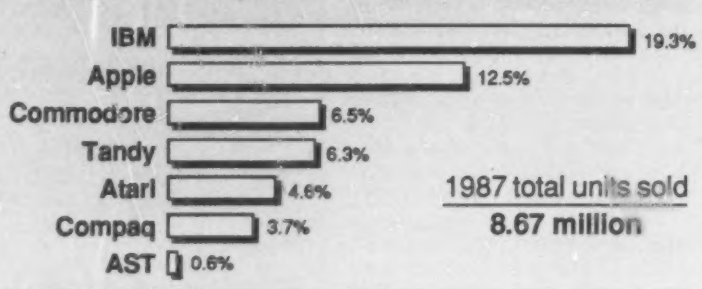
External factors are also at play in the long-term success of AST's systems. The switch by IBM to the PS/2 PC, introduced in April of 1987, dealt a serious blow to AST's existing PC AT and XT board business. The new environment will also determine how well AST's new PS/2 board products pick up the slack.

Also, the standard being set by the new IBM Micro Channel — the multitasking bus system that takes full advantage of the power of the new 80386 processors — is being challenged by AST with its own proprietary SMARTslot architecture. The SMARTslot is compatible with the AT bus and is designed for multiuser environments. Whether or not SMARTslot catches on as an alternative to the PS/2 architecture will play a role in the success of the Premium/386. "If it is picked up by the industry, then we will really put our emphasis on [the SMARTslot]," comments Yuen.

But skeptics abound. Harvey Allison, a vice president for securities firm Wertheim, Schroder and Co. in New York City, says the advantages of the SMARTslot are very "iffy." He does not think an AST slot innovation is as interesting to the market as a new architecture from IBM.

Yuen sees the shift to a PS/2 environment as an advantage for AST, whether SMARTslot catches on or not. "IBM's move to stop manufacturing the PC AT and XT is a change that is creating a lot of opportunity," he claims. It enhances AST's ability to serve the existing PC AT and XT base and improves its ability to migrate these machines, along with its own Premium/286, up to the more powerful 80386 environment. Also, the Premium/386 runs at three speeds and is compatible with existing AT software. Because of AST's two-pronged market presence, it is able to capitalize on both the successes and failures of the PS/2: "We don't get mad with IBM," quips Yuen. "We are friends and foes."

In 1987, AST is still a minnow in PC seas



Source: Dataquest Inc.

AST forecasts that the systems market will grow at a 25% clip and that it will outperform the market

AST recently announced an expanded memory board for the PS/2 models 50 and 60, the Rampage/2-386, and one for the PS/2 model 80, the Advantage/2-386. It also introduced two boards that will handle the memory requirements of Microsoft's new OS/2 operating language.

Despite some problems on the balance sheet and income statement, most analysts are confident that AST can pull the transition off. "I think they understand what their problems are, they are working on it and they will make it," says analyst Lorenzo. The growing pains, however, are very real.

Lorenzo criticizes the company for losing focus of its board business as it grew its systems business, charging that AST left an opening for competitors to attack its board base. He also chides the consensus management style of AST's founders as being too time-consuming in such a swiftly changing market. "The founders have to delegate more responsibility and accept that they cannot oversee everything," Lorenzo says.

As a result of both internal and external factors, AST took a hit in the 1987 September quarter — the fiscal 1988 first quarter — as net income skidded to $72,000, down from over $8 million for the same quarter one year earlier. "It was a real disappointment both for Wall Street and for themselves," says Lorenzo. Despite healthy sales for the September quarter, inventories rose precipitously, net income was way down and AST's usually strong cash position was compromised. Higher expenses and a drop in PC AT and XT board sales caused by the transition to the IBM PS/2, have left the company in a weakened financial position.

"It's a problem, no doubt about it," agrees Blake Childs, an analyst with the Los Angeles firm of Bateman, Eichler, Hill, Richards Inc. Of AST's $78 million September quarter sales, only $30 million was in boards. Board sales were off about $9 million, or 22% from the previous year. Childs estimates that about 40% of AST's board sales were for IBM PC machines. When the PS/2 hit the market, people stopped buying add-on boards for their PCs and AST was forced to write down about $2.7 million worth of inventory on board level products.

Childs expects another write-down in the December 1987 quarter, but an AST spokesperson claims that will not happen, pointing out that as the new AST PS/2 boards begin to take off early this year, they will compensate for the drop in traditional board sales. Still, the company concedes that "inventory levels are higher than we would like."

As for the paltry net income in the September quarter, it can be traced to a few sources. Gross margins on

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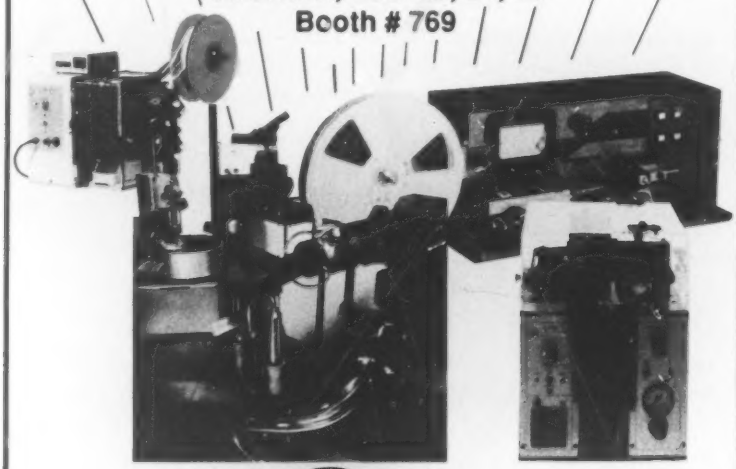

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boards traditionally run between 45% and 50%, while systems only average in the low 20% range, and higher inventory levels tend to pull margins down. The start-up costs involved in penetrating a new market and restructuring the company are also reflected in the lower net income. Most notably, research and development costs are higher. For fiscal 1986, R&D was over $11 million, compared with $8 million for 1985. The company claims that R&D will stay in the $11 million range for the foreseeable future, but will decline in significance as revenue grows.

Despite the poor financial showing, AST is not about to retreat. Besides its Irvine operation, AST has a two-and-a-half year old manufacturing facility in Hong Kong — home of founders Yuen and Wong — and is setting up a manufacturing plant in Taiwan to cater to the systems business. It also has marketing offices in Australia, Britain, Canada, France, Germany and Hong Kong. As in the United States, the company prefers to sell through resellers and distributors internationally. AST derives about 25% of its revenue from overseas sales, two-thirds of which is from Europe. "We continue to believe that the majority of our product has to be made in the U.S., but we can use the overseas strategy to help us compete against people like IBM," says Yuen.

The Pacific Rim is one of the fastest growing markets for personal computers, and AST is hot on the trail. In November, after only six months of pushing the systems overseas, the company announced two important deals in Hong Kong for the sale of Premium/286 machines: 50 units for the Bank of Hong Kong and 270 units for the government of Hong Kong. "We are hopeful to ship double the original order quantities by the end of June 1988," claims AST's Nelson. The sale to the government of Hong Kong is a feather in AST's cap because AST is now the standard by which future government purchases will be judged.

Other Pacific Rim countries that AST is targeting are Thailand, Singapore, Malaysia and Indonesia. The Thai market is particularly promising because AST's local distributor has mapped the screen into the Thai language. "We are perceived as a company with an international image but local content, which is always our goal at AST International," says Nelson. □

MILITARY ELECTRONICS

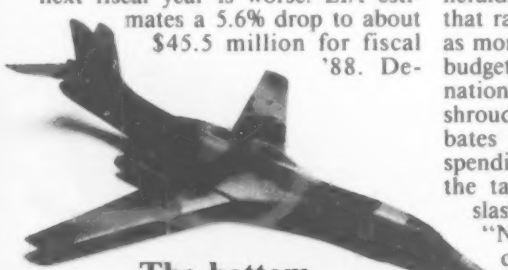
Defense spending: Sorry, but it's down for the decade

And defense electronics is down with it. But war games, C3I and space offer some relief for alert military contractors

By Bruce C.P. Rayner

After months of haggling, Congress and the White House finally agreed in late November to cut about $30 billion from the 1987 federal budget, just enough to sideline the Gramm-Rudman automatic spending cuts of $23 billion. The consequences for defense spending were as expected, with cuts of $5 billion, producing a total budget of between $289 billion and $295 billion. Still, defense contractors will have to get used to a perpetually shrinking defense budget for the next few years, as Congress grapples with trade and budget deficits.

The bottom line for the electronics content of the R&D and procurement categories of the defense budget is a $1 billion cut to $48.2 billion for fiscal 1987, beginning last October, estimates the Electronics Industry Association (EIA). The outlook for the next fiscal year is worse. EIA estimates a 5.6% drop to about $45.5 million for fiscal '88. Defense electronics will continue to contract through the early 1990s, somewhat more slowly than the general defense budget, and will remain pretty flat through to 1997, the EIA forecasts. However, the percentage of spending on electronics will increase to around 40% in 1988 and hold its own through 1997.



The bottom line for the electronics content of the R&D and procurement categories is a $1 billion cut to $48.2 billion for fiscal 1988

"There is no safe place to hide; everybody will feel it," comments Byron Callan, defense electronics analyst with Prudential-Bache Securities Inc. in New York City, referring to the defense squeeze. Acquisition activity will increase and competitive pressures from both domestic and foreign companies will intensify now that the pie is smaller, he says. With the budget cuts exacerbated by mounting economic concerns, the defense marketplace will be an altogether tougher place to do business.

The contracting defense budget heralds a new congressional austerity that ranks domestic economic issues as more critical than a static defense budget. The concern with the huge national debt and trade deficit is a shroud that will hang over budget debates well into the 1990s. Defense spending, most analysts agree, will be the target for future congressional slash-and-burn exercises.

"No one is immune from the cuts," says Barbara Bruser, senior defense research analyst with the Security Pacific Merchant Bank, in Los Angeles. "It will affect the defense electronics companies as much as it will affect everybody else," she predicts.

The immediate consequence of the defense cuts, electronics included, will be to put a squeeze on weapons research and to stretch out the procurement of new systems. While the prime contractors will feel the pinch immediately, it will take a while for the full impact to ripple down to subcontractors. The cuts are selective, based on need and practicality — the House of Representatives slashed a computer for the Army command and control system (ACCS), the Advanced Field Artillary Tactical Data System (AFATDS) and other multimillion dollar projects for fiscal 1988 with one stroke of the pen —so the luck of the draw appears to play a role in who gets hurt and who does not.

Martin Cooke

Space electronics and the training and simulation market are two examples of positive growth areas

The electronics and communications category of the Department of Defense's research and development and procurement is expected to grow from $9.1 billion in 1987 to $9.3 billion this year, and will reach a peak of $10.1 billion in 1989 before leveling off at $10 billion through 1992, the EIA predicts.

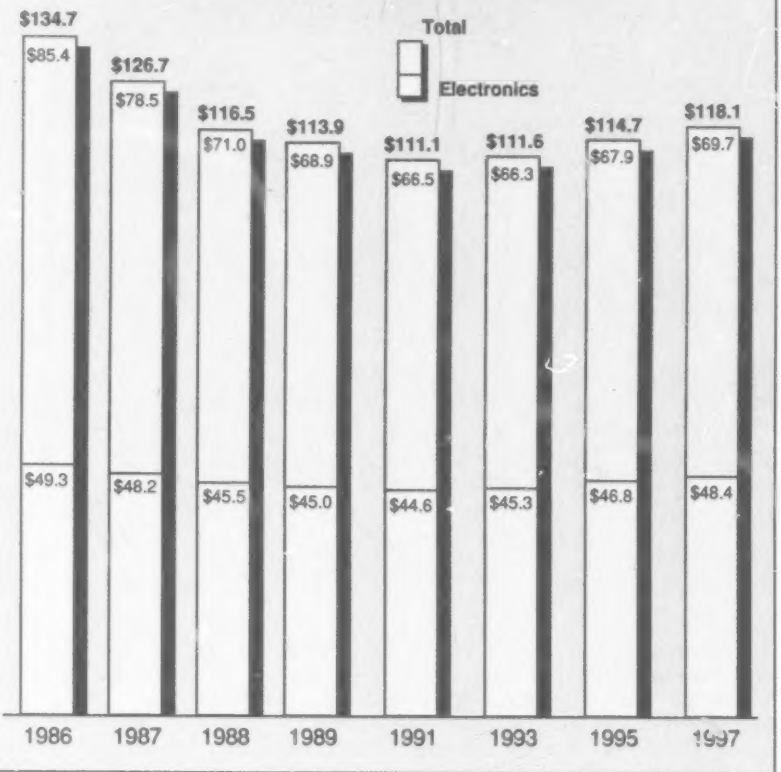
New reality

This DOD spending contraction is the new reality. But it is not as bad

Defense scorecard: Congress 1, Pentagon 0

Defense electronics will continue to contract through the early 1990s and will remain fairly flat through 1997, but the percentage of spending on electronics will increase to around 40% in 1988 and hold its own through 1997

Total DOD procurement and RDT&E budget forecast
(Constant FY 1988 $ billions)



Source: Electronic Industries Association

as it sounds, at least not for those companies that have their resources in the right places and are heavily involved in electronics. Looked at from a long-term perspective, the actual size of defense spending remains significantly higher than it was through the 1970s. Looked at from a long-term perspective, this dip is a part of the natural cycle in defense spending. After the 8% annual real growth in military spending of the early 1980s, the slowdown was a sure bet.

"We watch our programs very carefully, and at the moment it appears that we are going to come out pretty well," says Larry Hallfin, director of business and strategic planning for Honeywell Inc.'s aerospace and defense business. The reason, says Hallfin, is that Honeywell is a subcontractor for avionics, marine and space electronics, three areas of defense spending that will remain relatively steady.

Subcontractors like Honeywell feel somewhat insulated relative to prime contractors. As contracts for platforms — ships, planes and tanks — get cut, prime contractors feel the impact immediately whereas subcontractors can shift their attention to retrofitting or upgrading existing inventory. Hallfin estimates 6% average growth for Honeywell's defense electronics business in 1988. "We recognize that the budget is flat and don't see renewed growth, but we teink we are pretty well positioned," he adds.

But why settle for flatness? "There are still pockets of growth in the shrinking overall budget," comments the optimistic Lior Bregman, defense electronics analyst with the consulting firm of Hambrecht and Quist Inc., in San Francisco. Space electronics and the training and simulation market are two examples of positive growth areas that Bregman identifies.

George Brown, executive vice president of the Lexington, Massachusetts-based economic forecasting firm of Data Resources Inc., and a longtime Pentagon watcher, suggests that command, control, communications and intelligence (C^3I) is another growth area. This category includes space programs like MILSTAR satellite upgrades as well as ground-, sea-and air-based communication systems. Another area of growth is research in antisubmarine weapons systems — a market that both IBM and AT&T are actively involved in —that is a high priority given the recent advances in Soviet submarine technology. The real weaknesses will be in weapons and tracked vehicles, some aircraft procurement as well as slippage in the ship-building budget, Brown esti-

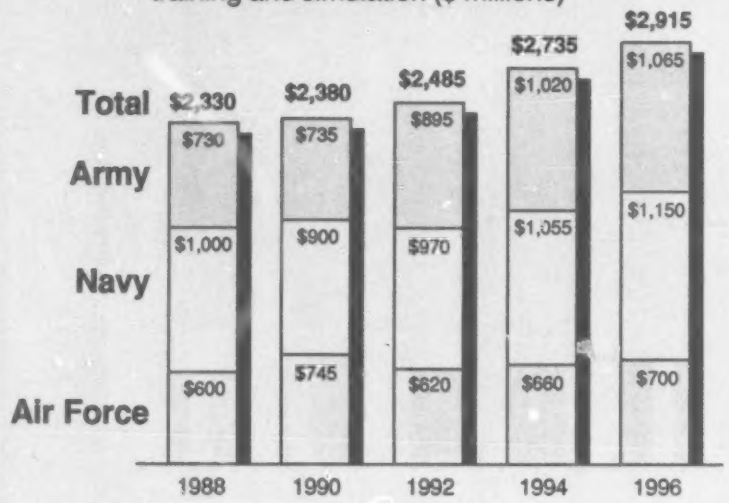
Martin Cooke

EIA estimates that the training and simulation market is currently worth more than $2 billion annually

War games, anyone?

Alert defense contractors are finding that the market for electronic equipment used for training and simulation is worth over $2 billion, and is growing

DOD budget for electronic equipment used for training and simulation ($ millions)



Source: Electronic Industries Association

mates. Electronics research and development in general will remain healthy through 1989, he adds.

Similarly, the space budget, that includes Reagan's Strategic Defense Initiative (SDI), will continue to grow through the 10-year EIA forecast period, posting $6.3 billion for 1988. Although diverging significantly from the $5.2 billion DOD request, SDI will account for over $3 billion of total space monies in 1988, the EIA projects.

For companies like M/A-COM Inc., the Burlington, Massachusetts-based electronic warfare, missile guidance systems and satellite communications subcontractor, the space budget is not such bad news. "These [tactical] areas, if they follow the same trend that has been happening since 1985, will probably be less impacted than the strategic areas and areas such as the large phased-array radars where the money has been slow," comments Joseph Bothwell, M/A-COM's senior vice president. But still, some of M/A-COM's orders have been delayed since 1986 due to budget cuts. Says Bothwell: "It is possible that those orders may be delayed until 1989."

Milton Silveira, director of advanced requirements and analysis at Ford Aerospace & Communications Corp., claims that even though the overall defense budget will be going down, C^{3}I will remain pretty flat or could possibly even increase. "I wouldn't say it is healthy, but [C^{3}I] looks to be one of the more promising areas," he says. As a result, Ford Aerospace is concentrating a lot of its efforts in the C^{3}I area for the Army, Air Force and SDI, Silveira adds.

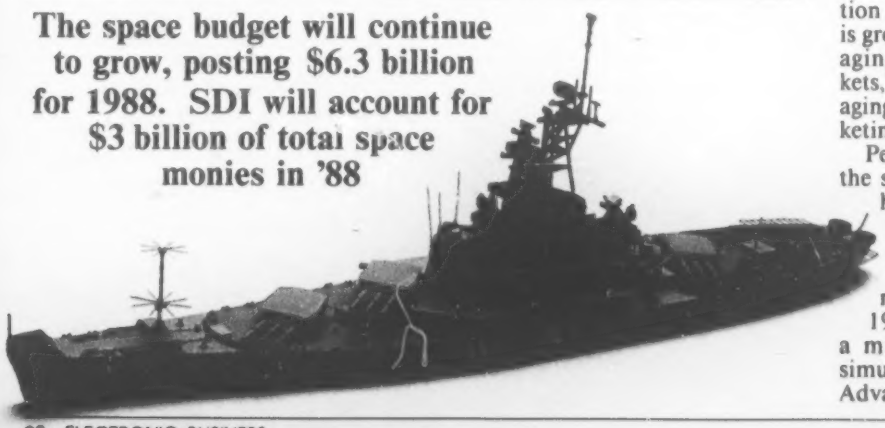
C^{3}I will continue to be relatively healthy because it acts as a "force multiplier" that lets a commanding officer get more value out of his resources. In essence, it is a cost-effective investment that enhances hardware and manpower capabilities. The same goes for simulation and training equipment. Instead of training pilots in real F-16s, or tank drivers in real M-1 tanks — equipment that can wear out, use fuel and can crash —a sophisticated simulator is substituted. It takes advantage of artificial intelligence and satellite networking so simulators around the world can be hooked together for simulated battles. As a result, any procurement that will ultimately save the Pentagon money is pretty much a sure bet these days.

The EIA estimates that the training and simulation market is currently worth more than $2 billion and is "growing moderately." It includes antisubmarine weapons (ASW), electronic warfare (EW) training systems, command and control trainers and flight simulators, that in some cases are made up of over 90% electronics.

Imaging Technology Inc., a $15 million privately held Woburn, Massachusetts-based subcontractor making simulation weapons and flight systems, is profiting from the simulation market. "The defense business is growing, definitely growing, for imaging processing in military markets," insists Robert Birenbaum, Imaging Technology's director of marketing.

Perceptronics Inc., a rising star in the simulation market, is also riding high. The Woodland Hills, Calif., company doubled sales from $15 million in 1985 to nearly $30 million in 1986 and reached $38 million in fiscal 1987. Perceptronics is involved in a multimillion dollar, large-scale simulation network with the Defense Advanced Research Projects Agency

The space budget will continue to grow, posting $6.3 billion for 1988. SDI will account for $3 billion of total space monies in '88



Martin Cooke

(DARPA), called the SIMNET. The SIMNET program includes several hundred simulators of various types, including the M-1 tank simulator networks.

On the component level, both the very high-speed integrated circuit (VHSIC) and the gallium arsenide (GaAs) monolithic microwave integrated circuit (MIMIC) programs are slated for applications in military hardware and look to have steady growth through the 1990s. The $336 million DOD-funded VHSIC phase-two research jprogram will wind down in 1989, and by 1992 VHSIC chips will find their way into missile guidance systems, signal processors and radar systems. MIMIC is only about a year old and is still in the early stages of research and development.

"VHSIC is important to us not simply for the sales of VHSIC technology, but for the insertion into systems. It will give us leverage in our systems business," says John Mellen, director of strategic planning and analysis for TRW Inc. VHSIC will be used in TRW's integrated avionics, electronic warfare systems and in space applications such as the MILSTAR satellite.

The "black" defense budget is growing "astronomically" to an estimated $22 billion for fiscal 1988, up from about $4.6 billion in 1984

TRW is also involved in the phase zero, or research stage, of the MIMIC program, teamed with Honeywell Inc. and General Dynamics Corp. for about $1 million in DOD funds and is bidding on phase one this year. There are about 12 teams at the phase zero level; each has about $1 million in funding. MIMIC is complementary to VHSIC in that it represents the analog front end of weapon or command and control systems while VHSIC is the digital brain.

Black is beautiful?

While growth can be identified in some military markets, it is a guessing game in others. The "black budget" — those programs that are kept under lock and key for security reasons — are hard to gauge, both in terms of size and in terms of growth potential. It is rumored that some black projects that are budgeted to one agency, such as the Central Intelligence Agency, can find their way into the DOD budget, and vice versa. Keeping track of the black budget is no easy task.

The Center for Defense Information (CDI), in Washington D.C., estimates the black budget at about $22 billion for fiscal year 1988, up from an estimated $4.6 billion in 1984 and $19 billion in 1986: a growth rate that CDI senior analyst Brian McCartan calls "astronomical."

McCartan estimates that about $15 billion of the $22 billion is for the Air Force including: the B-2 stealth bomber, built by Northrop Corp.; the F-19, built by Lockheed Corp. with about 50 currently operational; and the stealth cruise missile. The remainder of the $22 billion is shared between the Navy, for its stealth advanced tactical aircraft (ATA), with a total price tag of $45 billion over its production lifetime, and various space research projects, CDI estimates. Although no hard facts are available, much of the black budget is in advanced electronics.

Because electronics accounts for about one-sixth of the total DOD budget, most prime contractors are positioning themselves to capture a piece of the high-tech action. Bruser at Security Pacific sees the trend for prime contractors getting into the systems and subsystems market intensifying.

Industry experts agree: "You are going to see more consolidation in the industry," says TRW's Mellen, with airframe houses acquiring electronics firms. Recent examples of this trend include Lockheed buying out Sanders in 1986, Boeing acquiring Argo Systems in mid-1987 and Tracor being swallowed by Westmark Systems Inc. last September.

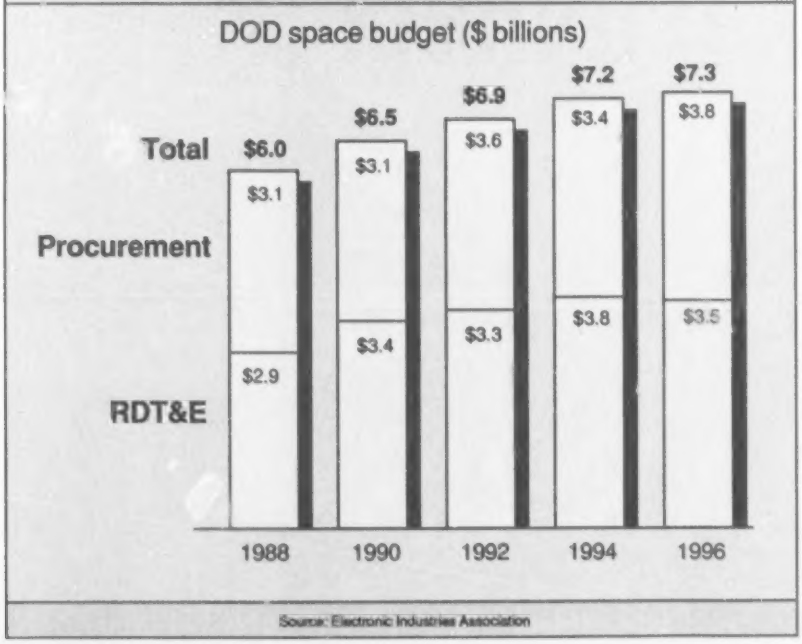
"Some of the other aerospace concerns that have been more aligned to airframe [manufacturing] have more of an interest in getting into fields that we are into," comments David Snyder, senior vice president for domestic and international marketing at GM Hughes Electronics.

The acquisition trend will intensify, some experts say, simply so defense contractors can survive. Breg-

Martin Cook

Heavenly profits

Defense contractors that are focused on space electronics have less to complain about. The space budget will continue to grow strongly through the 1990s



Source: Electronic Industries Association

man at Hambrecht and Quist favors the building block strategy of acquisition that Boeing has been pursuing. "It favors synergies," he says.

Hold that acquisition

But according to DRI's Brown, acquisition activity is in a "reassessment mode" given Wall Street's Black Monday last October. As a result, some acquisitions may be put on hold. With the reduction in prices on the stock exchange, companies are now better value for the dollar. But the sword cuts both ways. The value of the acquiring company's stock has also dropped, lowering the value of its own assets and making funds for acquisition harder to come by.

Other factors play a role, too. Overcapacity, increased cost of audits and intense competition — promoted by the DOD — have all defense contractors firmly wedged between a rock and a hard place. The DOD expects more research, development and tooling costs to be borne by the contractor; profit margins have been cut; and controversial guidelines for increased competition have all helped to lessen the contractors' ability to make a buck. The 1985 Competition in Contracting Act is at the heart of the problem, such that second sourcing and recompetition are being applied across the board, even where they do not make economic sense.

An oft-cited example of this kind of redundancy is the Advanced Tacti-

Defense goes global

While domestic defense contractors are trying to soften the blow of increased competition, foreign companies are having a field day, both in terms of teaming efforts and in terms of potential acquisitions. Hungry foreign investors are bullish on U.S. defense because the U.S. dollar is so low. A case in point is The Plessey Company Plc's purchase of Marion, Massachusetts-based Sippican Inc. for $78 million two months ago. Sippican is in the relatively healthy field of antisubmarine warfare instrumentation and makes for a lucrative move by Plessey. The expectation is for more foreign investment in the near future.

That the defense industry is becoming more international is just a fact of life. The U.S.-NATO two-way street — that used to be an 8-lane freeway into Europe and a cow path into the United States — is slowly becoming equal. The Center for Defense Information estimates that Department of Defense's sales to NATO and Canada have dropped from $9.8 billion in 1984 to $4.5 billion in 1986. At the same time, the DOD increased its purchases from those countries from $2.1 billion to $2.9 billion over the same period. Similarly, two years ago, France beat the United States as the No. 1 source of arms for the third world, and last year, Britain beat France.

Defense nondevelopmental items purchases are growing and almost by definition are foreign sourced. They account for a large chunk of the DOD's foreign sourcing with McDonnell Douglas Corp. producing the British Harrier jump-jet for the Marine Corps; and GTE Corp. building the French RITA-MSE, the battlefield cellular-telephone system.

Teaming efforts between U.S. and foreign companies are also more prevalent. In fact, all of the contenders to replace the Sergeant York division air defense (DIVAD) weapon with the $6 billion forward area air defense system forward heavy (FAADS-FH) are European companies teamed with U.S. counterparts.

The DoD's sales to NATO and Canada have dropped rom $9.8 billion in 1984 to $4.5 billion in 1986

U.S. companies are also more active in foreign markets, even though it is admittedly a hard row to hoe. General Dynamics Corp. is actively selling fighters all over the world, including a recent contract for 170 F-16s to Japan. And Lior Bregman at Hambrecht and Quist Inc. points to Dallas-based E-Systems Inc. and New York City-based Loral Corp. as two that are doing well internationally. Both recently received $500 million contracts internationally, he says.

In research and development, electronic warfare specialist Loral has struck up a deal with Israel. This kind of business move makes sense for all concerned, claims Bregman. Israelis have real battle experience that adds a certain pragmatism and the country also offers relatively cheap labor.

Treaties, summits and elections

Most defense analysts agree that the impact on the 1988 and 1989 defense budgets as a result of the December signing of the intermediate nuclear forces (INF) treaty by President Reagan and Soviet Premier Mikhail Gorbachev will be minimal. Data Resources Inc.'s George Brown echoes most analysts by speculating that the logical consequence of the INF treaty will be a build-up of conventional forces in Europe and more attention paid to verification and sensing equipment. But Brown insists, "it is going to unfold slowly."

As for the resignation of Secretary of Defense Caspar Weinberger, a strong proponent of SDI, and the appointment of National Security Advisor Frank Carlucci to the top defense post, again the short-term consequences for DOD spending will be minimal. In fact, they are likely to get lost in the budget deficit debacle on Capitol Hill. What is more important for the defense outlook is the election in 1988 and the possibility of a Democratic president in 1989.

With defense spending slated for decline over the next few years, a hard-hitting new administration will most likely be inclined to make a strong political stand on the budget deficit. □

Martin Cooke

cal Fighter (ATF) that the Air Force is developing. The nonrecoverable development costs that the two competing teams of Lockheed-Boeing-General Dynamics and Northrop-McDonnell Douglas have to front is estimated at $600 million each. But, only one team will win the contract.

On top of these changes in DOD procurement policy, the Tax Reform Act of 1986 is another thorn in contractors' sides. Although lowering the tax rate, the act effectively eliminates the investment tax credit (ITC) and the completed contract method of accounting for taxes. The removal of the ITC raises the cost of a contractor's capital investment while the cancellation of the contract method means that the contractor can no longer defer taxes until the project is complete. Both negatively affect cash flow.

"The long-term consequence is that capital won't go into the industry and people won't invest in it," says Robert Fraser, vice president for the aerospace practice at the consulting firm of Arthur D. Little Inc., in Cambridge, Mass. Fraser contends that unless something is done to change the current policies, companies will divest out of the defense business and there will be no contractors left. But divestiture is already happening, and not only to the small fry.

Such a case is Eaton Corp., which announced at the end of October that it will sell off its $900 million defense electronics business. Eaton is building the electronic countermeasures for the B1-B strategic bomber that is nearing the end of its production cycle. Faced with the need to make huge investments in its defense business to keep it a viable competitor, the company chose instead to exit. "We are convinced that the financial and management resources we would need to apply in order to get bigger are better employed if directed to commercial markets," writes James Stover, Eaton's chairman.

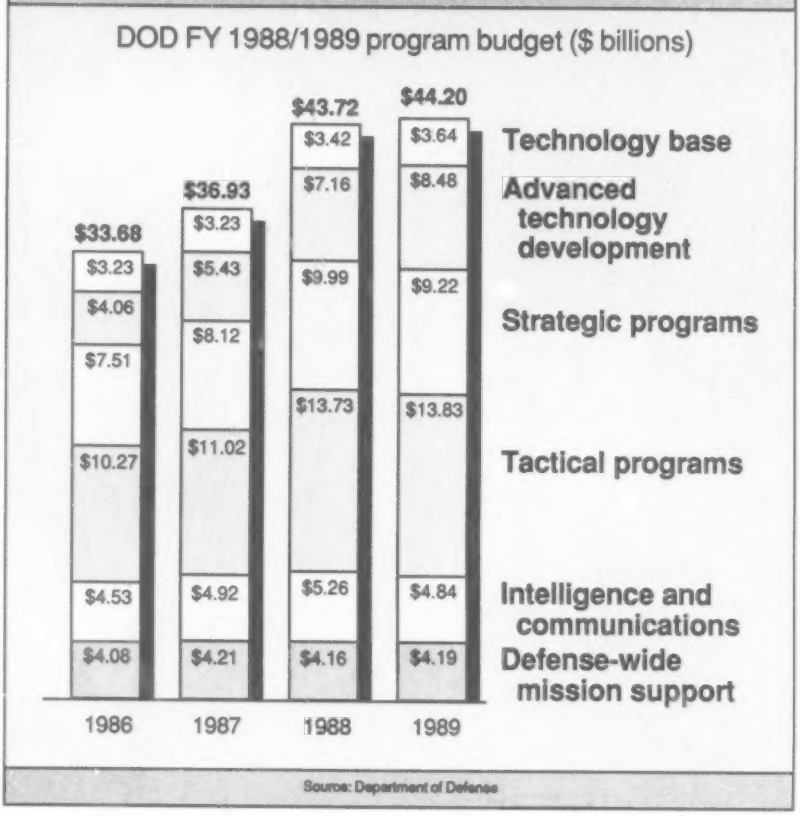
Tough to be optimistic

"It's very tough to be optimistic," says a Lockheed Corp. spokesperson about the state of business. Lockheed, one of eight prime contractors to the Department of Defense, has put its ship-building business on the selling block and has restructured its three aeronautics divisons into one to try to cut costs.

Hughes' Snyder agrees that underfunding, second sourcing and increased audits are putting a strain on the bottom line. It has gotten to the point, he says, that if it does not look like Hughes will make money on a project, the company will not even bid on it. "We won't take a program on if we can't see a way that we can be ultimately profitable," he says.

Where the research dollars go

SDI research requests will fuel growth in the advanced technology development budget



Source: Department of Defense

A recent DoD directive calls for a move back toward some form of cost-plus contracts for certain R&D programs

Both the Congress and the Pentagon have been applying the piecemeal approach in order to increase efficiency and competition. But according to ADL's Fraser, this is not working; the rules that are now being made up, he says, will defeat the very intent of creating a more efficient industry. The darkest scenario would be some form of nationalization: a government-owned, contractor-operated industry. "I hope we will have more sanity than that," says Fraser.

Indeed, a ray of sanity does appear to be shining through. A September directive, number 5000.1, by the DOD's Deputy Secretary of Defense, William Taft IV, calls for more streamlining, more off-the-shelf componentry and subsystems — also known as nondevelopmental items (NDIs) — and a move back toward some form of cost-plus contracts for certain research and development programs. Until now, the trend has been toward fixed-price.

In regard to the cost-plus issue, the directive states: "Contract type shall be consistent with all program characteristics including risk. Fixed-price contacts are normally not appropriate for research and development phases. For such efforts, a cost-reimbursable contract is preferable because it permits an equitable and sensible allocation of program risk between contracting parties." □

AI in Japan: Closing the gap with the U.S.

Japan's commercial activity in artificial intelligence still lags that in the U.S. But it is catching up rapidly

Stimulated by the Fifth Generation Computer Systems Project in Japan and by the renaissance of artificial intelligence research in the United States, many Japanese computer and office equipment makers are now investing heavily in AI technology. Fujitsu Ltd. now has more than 150 AI projects under development. A spokesperson at Fujitsu says that about half of those projects were jointly developed with the customers. And the computer division of Hitachi Ltd. has about 120 projects under development.

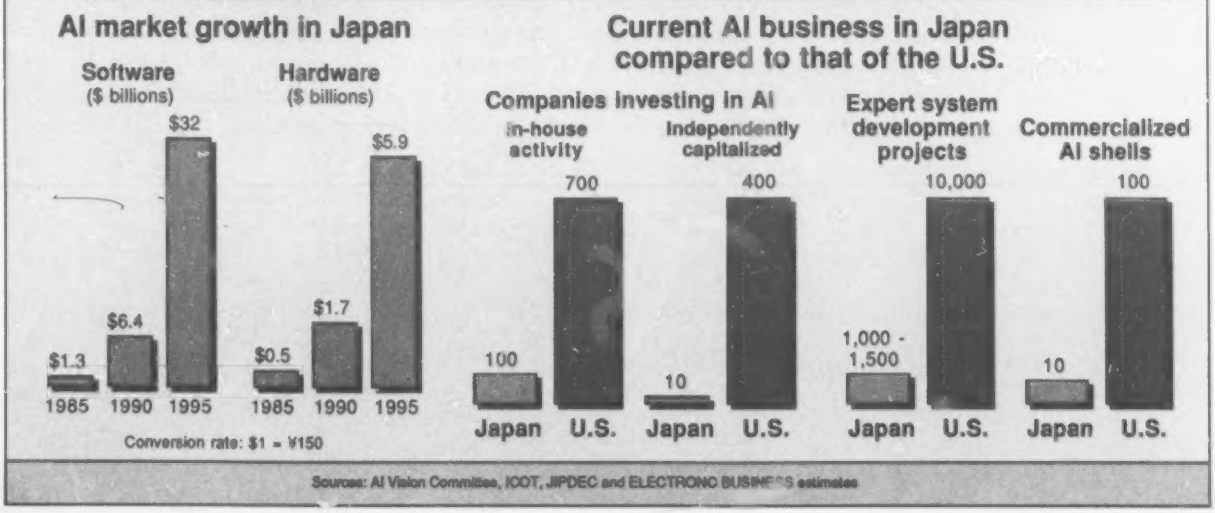
According to a forecast from the AI Vision Committee of the Japan Information Processing Development Center (JIPDEC), the Japanese market for AI software, including commercial software as well as software developed for in-house systems, is expected to reach $6.4 billion ($1 = ¥150); and by 1995, the market will soar to $32 billion. This represents an annual growth rate of 38%. The market for AI hardware, on the other hand, including all forms of computer architecture, will grow to $1.7 billion by 1990; by 1995 the hardware market will reach $5.9 billion. The estimates presuppose that Japan's gross national product (GNP) will grow 3.5% annually.

Nevertheless, for the moment, AI commercial activity is still limited in comparison to the current activity now under way in the United States. In Japan, the estimated number of companies investing in AI, including in-house activity, is less than 100, versus more than 700 in the United States. Similarly, there are only 10 AI businesses in Japan which are purely independently capitalized, while there are more than 400 such companies in the United States. Also, estimates show that at present there are 1,000 to 1,500 expert system projects under development in Japan, while in the United States, around 10,000 appear to be under development.

Additionally, about 2,500 copies of Japanese-made expert system shells have been sold to date. Of those 2,500 shell copies, 2,000 are for 16-bit microcomputers made by NEC Corp., Fujitsu, Hitachi and IBM Japan. The shell name "Sogen," which was developed by AI Soft, an independent business unit from Seiko-Epson, has already sold 1,700 copies since its introduction in June 1986. Until just a few months ago, there had been only one commercialized expert system on the market in Japan. The vendor is Nihon Shakai Iryo Kenkyusyo (Japan Medical Laboratory) and that first product is "Zhang Zhong Qing," an expert system which recommends herbs and other traditional Chinese medicines based on a description of the patient's symptoms fed into the system by a medical technician. Since its introduction in November 1986, the vendor has sold 28 of those software packages.

Last month, Japan Medical also introduced a natural language understanding system called "da Vinci," an intelligent interface to the system which allows a doctor specializing in this medical branch to prescribe herbs by using the knowledge base. The system is run on NEC's popular microcomputer, the PC9801, as well as on the IBM 5550, a machine which has been tailored to the Far East market. When Fujitsu announced its Knowledge System Architecture last July, more than 10 expert systems developed by customers were also demonstrated. They included an Ethylene Cracking Heater Operation and Maintenance Support System demonstrated by Toyo Engineering; and

A look at the artificial intelligence industry in Japan



Sources: AI Vision Committee, ICOT, JIPDEC and ELECTRONIC BUSINESS estimates

from Asahi Joho System, a Machine Diagnosis Expert System. It is now expected that various expert systems, targeting commercial markets, will be introduced by computer users in the next several years.

Japanese LISP

If one includes the sales of expert system shells, machine translation systems and higher language software products used in AI research, or in proprietary expert systems developed by large firms in conjunction with users, then the Japanese AI market is even larger than these product announcements suggest. Nihon Univac Kaisya (NUK), for example, has sold about 10 shell copies of Knowledge Engineering Environment from Intellicorp of Menlo Park, Calif., which runs on NUK's KS301 LISP machine. And DEC Japan has delivered more than 100 OPS5 shells, plus 150 systems offering VAX LISP, a very popular AI language. IBM Japan also is selling the AI products in Japan which were developed by its parent company in the United States. Of course, Fujitsu, Hitachi, NEC, Mitsubishi Electric Corp. and Toshiba Corp. are also marketing their own shells and higher level languages for their own machines.

About 10 computer makers and software houses are also marketing their own developed machine translation systems. To date, computer users have installed about 500 such systems for larger machines. Bravice International, an independent software firm, asserts that it has shipped about 2,200 copies of a machine translation system for microcomputers.

There are, of course, other demand forecasts for AI in Japan. The AI Vision Committee, organized by the Institute for New Generation Computer Technology (ICOT) and JIPDEC, forecasts the demand for both AI in-house and commercial markets. Based on the forecast data of the GNP, the gross revenue of the information and software industry in the forecast period and the result of a questionnaire survey to the computer users in all industries, the Demand Forecast Subcommittee concluded that AI has a bright future in the coming decade.

SHOHEI KURITA

Kurita, the author of about a dozen books on the Japanese computer industry, is also a contributing editor to ELECTRONIC BUSINESS

CALENDAR

UNITED STATES

Jan. 17-20. **Information Services Seminar**. Newport Beach Marriott, Newport Beach, Calif. Semiconductor Equipment and Materials Institute. (415) 964-5111

Jan. 19-21. **PCB Expo**. Omni International Hotel, Orlando, Fla. PMS Industries. (404) 475-1818

Jan. 25-28. **Communications Networks Conference and Exposition 1988**. Washington Convention Center, Washington, D.C. IDG Conference Management Group. (800) 343-6474

Jan. 26-28. **8th AFCEA Western Conference**. Showcase of C³I systems, subsystems and major components. Disneyland Hotel, Anaheim, Calif. AFCEA. (703) 631-6200

Feb. 7-11. **Electronic Distributors Management Institute**. Texas A&M University, College Station, Texas. National Electronic Distributors Association (NEDA). (312) 558-9114

Feb. 17-19. **Fourth Annual Semi-Custom Circuit Program Conference**. San Diego Princess, San Diego. BIS Mackintosh Inc. (617) 655-0001

Feb. 21-24. **CROSSTALK/88**. San Diego Hilton Hotel, San Diego. Electronic Industries Association. (202) 457-4930

CBG Feb. 23-25. **NEPCON West**. Anaheim Convention Center, Anaheim, Calif. Cahners Exposition Group. (312) 299-9311

Feb. 23-25. **BUSCON/88 West**. Disneyland Hotel, Anaheim, Calif. MultiDynamics. (213) 402-1610

Feb. 23-25. **Power Electronics Conference**. Disneyland Hotel, Anaheim, Calif. MultiDynamics. (213) 402-1610

CBG March 7-10. **Spring National Design Engineering Show & Conference**. McCormick Place North, Chicago. Cahners Exposition Group. (203) 964-0000

March 8-10. **Southcon**. Orlando Convention Center, Orlando, Fla. Electronic Conventions Management. (213) 772-2965

March 21-24. **NCGA '88**. Ninth annual conference and exposition dedicated to computer graphics applications. Anaheim Convention Center, Anaheim, Calif. National Computer Graphics Association. (703) 698-9600

CBG April 19-21. **Corporate Electronic Publishing Systems (CEPS)**. McCormick Place North, Chicago. Cahners Exposition Group. (203) 964-0000

April 26-28. **Electronic Distribution Show and Conference**. Las Vegas Hilton Hotel, Las Vegas. Electronic Industry Show Corp. (312) 648-1140

May 9-12. **COMDEX Spring**. Georgia World Congress Center, Atlanta. Interface Group. (617) 449-6600

May 10-12. **Electro/88**. World Trade Center, Boston. Electronic Conventions Management. (213) 772-2965

May 23-26. **SEMICON/West**. San Mateo Fairgrounds, San Mateo, Calif. Semiconductor Equipment and Materials Institute. (415) 964-5111

May 31-June 3. **NCC '88**. Los Angeles Convention Center, Los Angeles. American Federation of Information Processing Societies, Association for Computing Machinery, Data Processing Management Association, Institute for Electrical and Electronics Engineers (IEEE) Computer Society and Society for Computer Simulation. (703) 620-8970

June 4-7. **1988 International Summer Consumer Electronics Show**. McCormick Place, Chicago. Electronic Industries Association/Consumer Electronic Group (EIA). (202) 457-8700

June 7-9. **Robots 12**. Cobo Conference/Exhibition Center, Detroit. Robotics International of the Society of Manufacturing Engineers and Robotic Industries Association. (303) 271-0777

June 12-15. **Design Automation Conference**. Anaheim Convention Center, Anaheim, Calif. Association for Computing Machinery and IEEE. (303) 530-4562

CBG June 14-16. **NEPCON East**. Bayside Exposition Center and World Trade Center, Boston. Cahners Exposition Group. (312) 299-9311

June 14-16. **42nd International AFCEA Convention**. A C³I event. Washington

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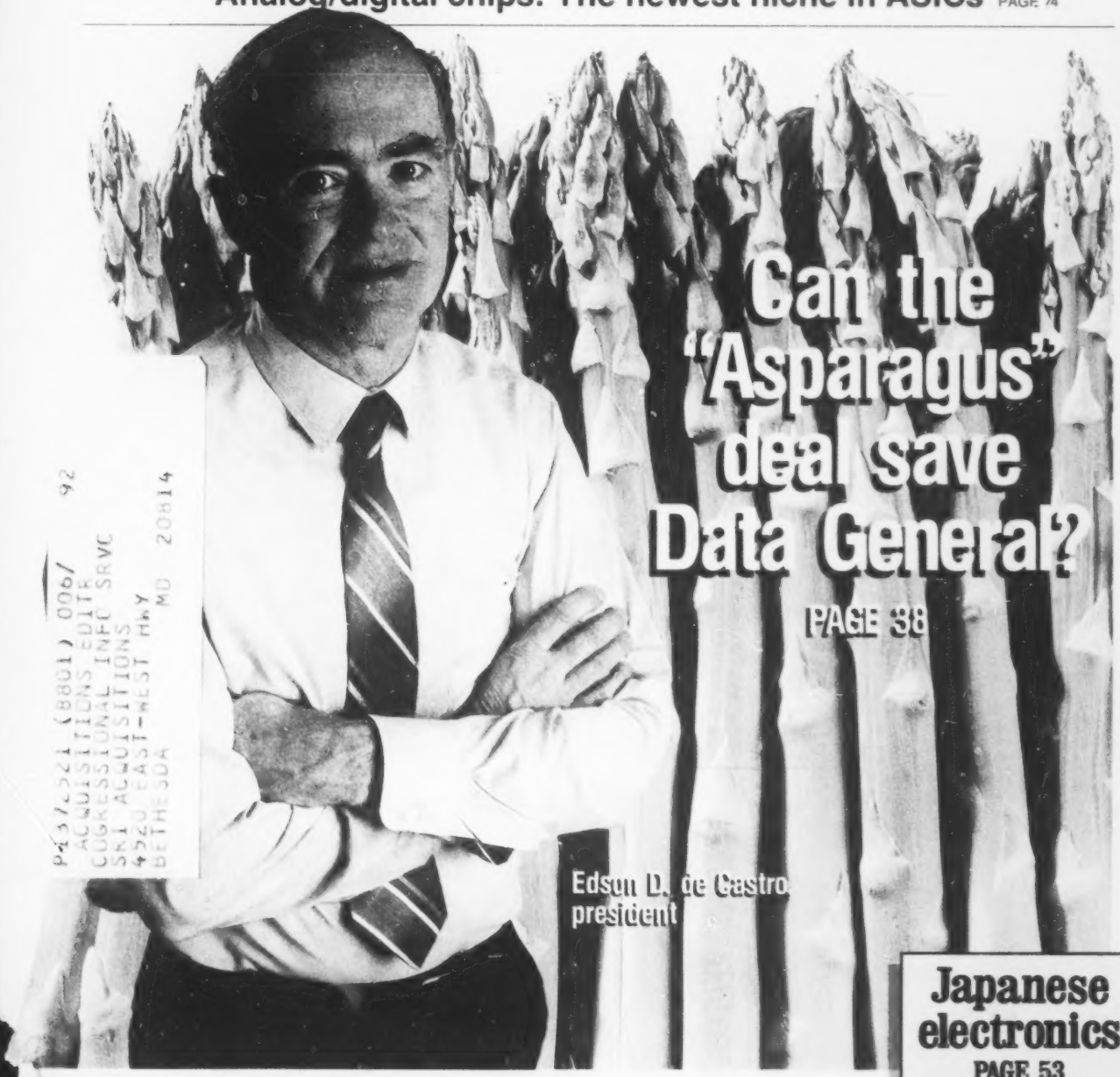

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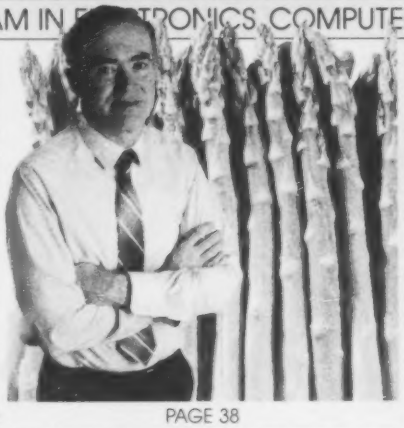

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Cover photo: Dave Bradley

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Accentuating the positive: A good year for distribution

What crash? Distribution orders keep going up, while cancellations don't

Last October 19, the day the stock market crashed, Avnet Inc.'s board chairman Tony Hamilton called an urgent teleconference with his outside directors. He wanted to know if their companies, which are in banking and computers, saw the crash as curtailing capital investment, which is the major engine that pulls the electronics industry in the United States. The directors saw no immediate impact but counseled caution, and to keep a watchful eye on the two major indicators of the distribution business: incoming orders and cancellations.

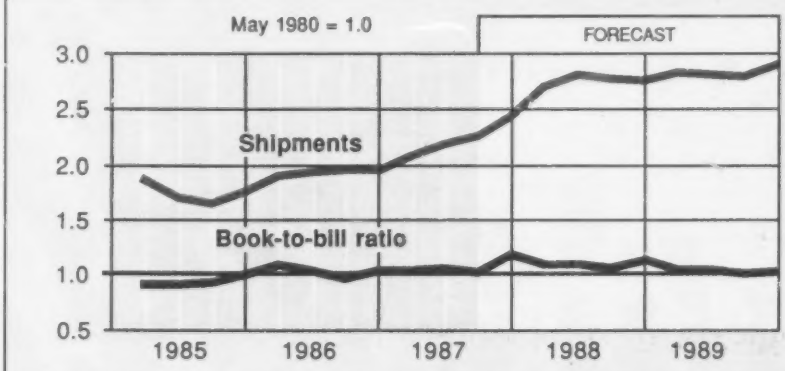
Like Hamilton, most other U.S. industrial distributors worried about their prospects for 1988. Fortunately, the number of positive indicators seems to overwhelm, so far, that single but large negative one from last October. The National Electronic Distributors Association's book-to-bill ratio not only kept its head above unity, but it closed October at 1.08. Moreover, November's ratio was even higher, at 1.10, the highest since April. For Avnet's Electronic Marketing Group, which by itself represents a volume of business half as large as that of the 17 distributors that make the NEDA sample combined, November's book-to-bill ratio was 1.20, a record for the year. If distribution customers had wanted to cancel orders, they had plenty of time to do so in October and November. Avnet's orders kept going up in December, yet "we've seen no change in cancellations," says the obviously pleased Hamilton.

The reason for the strong distribution orders, according to the engineering manager of a small New England company that builds industrial automation based on Intel Corp.'s newest microprocessors, is that his company's life depends on distributors. "I can't compete with Compaq," he laments. "Intel puts me on allocation; my only hope is the distributor. To have more clout, I buy then, from the distributor, most of my components." This suits Hamilton/Avnet Electronics — the major unit of Avnet's EMG and Intel's largest distributor — just fine. "Our business is made up of a series of small orders," explains Hamilton.

The NEDA index for shipments ended 1987 ahead of 1986, by 15%, and the association looks forward to at least 16% for 1988. "We'll be 33% ahead of NEDA's forecast in 1988, because of the things we have in the mill," says Hamilton. NEDA may be conservative. Based on NEDA's shipments and using the Cahners Early Warning Indicator, senior economist Elizabeth Baatz of Cahners Economics forecasts 24% growth for shipments in 1988. Even at that, Hamilton may be right. The things Avnet has "in the mill" include a forecast by Digital Equipment Corp. that Avnet will distribute $500 million worth of DEC's products in 1990.

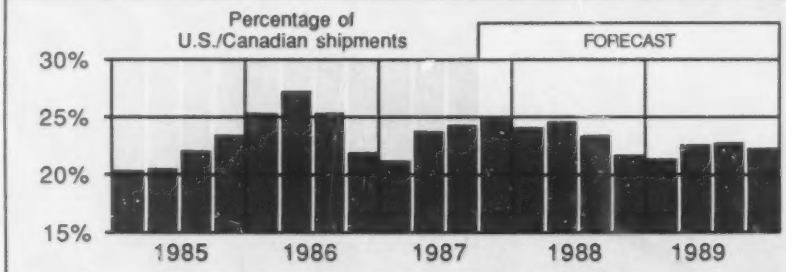
ALBERTO SOCOLOVSKY

Distribution business index



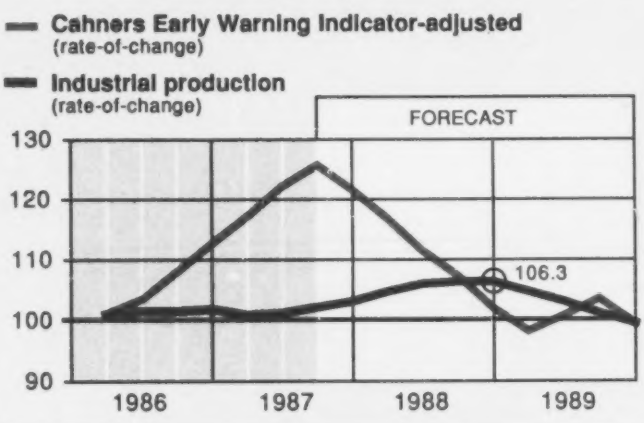
Source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' share of total semiconductor shipments



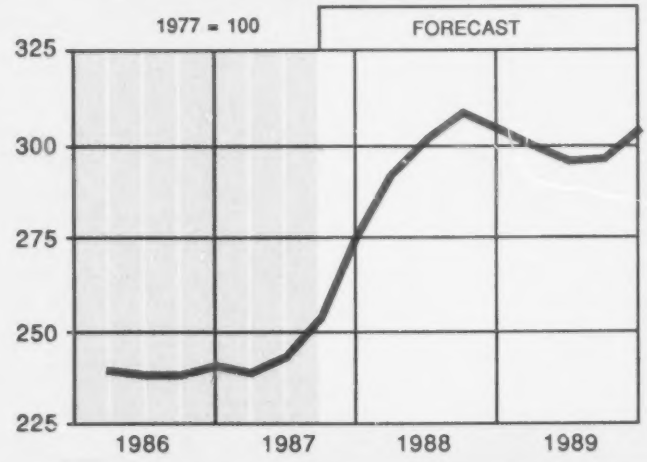
Source: Semiconductor Industry Association; Forecast: Cahners Economics

Economic indicators



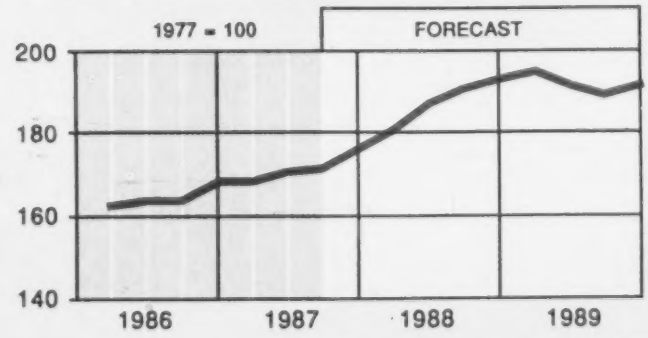
Electronic components

Industrial production index, seasonally adjusted quarterly averages



Equipment, instruments and parts

Industrial production index, seasonally adjusted quarterly averages



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. During 1987's third quarter, output rose 2.1% from the prior quarter and was up 3.1% year-to-date compared with the previous year. This slow and steady growth is expected to continue until this summer. Production is expected to rebound after a year and a half of sluggish growth, pushing production up 6.3% this year. The impetus for this upturn will be increasing U.S. exports, due to the decline in the dollar's value, inventory replenishment and growth in equipment investment.

The Cahners Early Warning Indicator (CEWI) has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. The CEWI is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2), deflated by the Consumer Price Index. The CEWI has proven to be an excellent tool in forecasting the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That change over a 12-month period can be determined by comparison with the line at 100. For example, the 106.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1988 should be 6.3% above 1987.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Equipment, instruments and parts

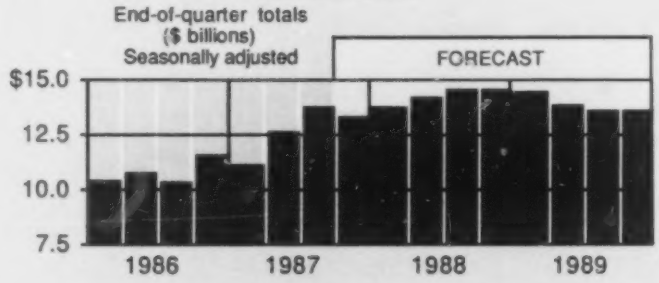
Output at U.S. factories of instruments and other equipment rose 0.5% in the third quarter of 1987 and is expected to rise another 2.6% in the fourth quarter. Shipments of scientific, engineering and manufacturing instruments hit a new record last summer and records will continue to be broken in 1988; and instruments production is expected to grow 9.5%.

Electronic components

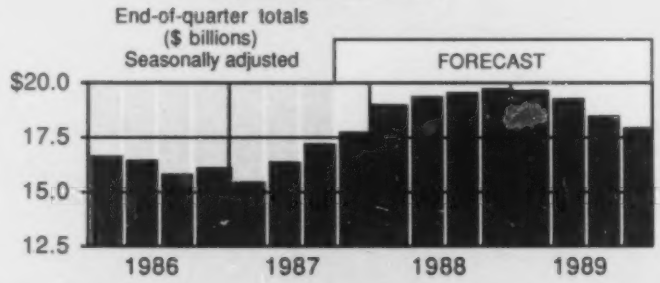
Electronic components output rose 4% in last year's third quarter. The fourth quarter is expected to show even more growth, as inventory stocks are rebuilt. By the end of 1987, components production is expected to rise 12%. The outlook for 1988 is 19% growth followed by a 1% drop in 1989. Capacitors, ICs and custom components will see the most growth in 1988. Passive components and commodity-type components will grow more slowly than average.

Electronic components (SIC 367)

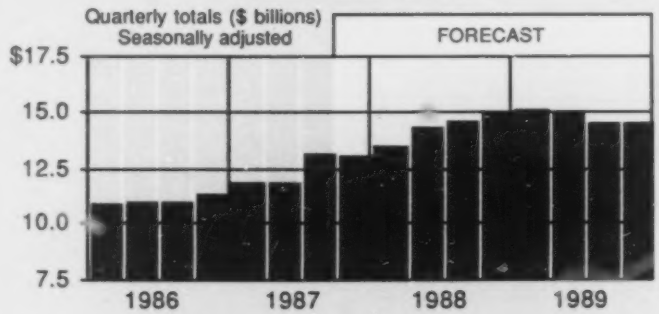
New orders



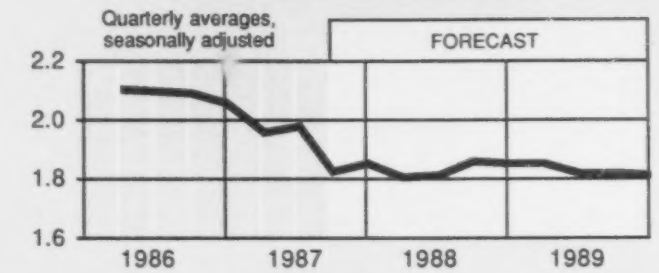
Unfilled orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

A 9% surge in component orders in 1987's third quarter will help boost new orders an estimated 18% in 1987. By September 1987, orders had risen 32% above the dismal 1986 September level. Last year's solid performance has set the stage for continued gains in sales and production this year. In a typical business cycle, orders hit their peak growth rates prior to other indicators. Orders are expected to peak early this spring, which means the business cycle downturn is likely by 1989. The growth outlook for 1988 orders is 13%, followed by a 3% drop in 1989.

Unfilled orders

After totaling a low of $15.1 billion in January 1987, unfilled orders for components jumped to $17.0 billion by last September, the highest since early 1985. Backlogs of components have held stubbornly low since the big buildup in inventories in 1985. Now that inventories have been worked down, backlogs are expected to expand. This will be the first positive annual gain since 1984. But compared with a 37% surge in backlogs in 1984, growth this year will be a more modest 18%.

Shipments

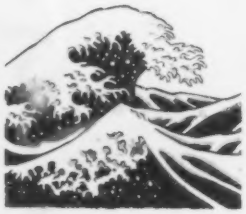
Shipments of electronic components jumped 11% in last year's third quarter and are expected to fall just 1% in the final quarter. With such a strong third quarter in place, shipments are expected to rise 12% in 1987, paralleling the gains in production and orders. Growth in U.S. shipments of components was fueled by gains in exports, a slowdown in import penetration of the U.S. market, inventory restocking and domestic end-market demand. The turnaround in the trade statistics should not be underestimated. The sharp drop in the value of the Japanese yen and European currencies is finally translating into stronger U.S. export demand. Shipments are expected to grow another 16% in 1988 and 3% in 1989.

Inventory-to-shipments ratio

The inventory-to-shipments ratio plunged dramatically last summer to average 1.83, the lowest quarterly ratio ever. The sharp rise in third quarter shipments was simply not matched by rising inventories. The ratio has dipped lower than ever before because inventories are being managed better. Computer tracking, tighter supplier relationships, and a commitment to just-in-time delivery are being reflected in these statistics. This year the I/S ratio will likely remain in the 1.8 to 1.9 range.

BY MASARU YAMANO

Sanyo sees major expansion for the optoelectronics market



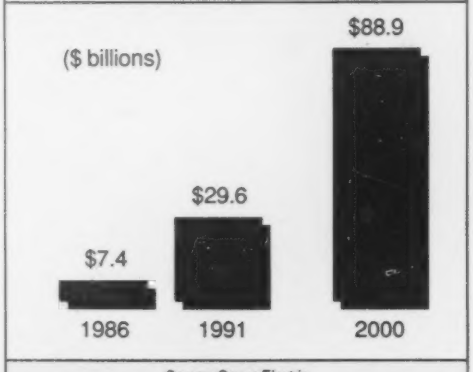
Optoelectronics

The abundance of goods and services available today to much of the world's population has been achieved to a large extent via technology. Mechanical technologies, once the main source of new developments, have given way to electronics technologies. And, in recent years, world attention has shifted toward such fields as optoelectronics, biotechnology, artificial intelligence and superconductivity. One of the key technologies in this group is optoelectronics. It will have a profound impact on all aspects of the transmission of information, promising improvements in speed, density, capacity and cost.

In the electronics industry, the development of one key component can create a whole spectrum of new products and can lead to further technical breakthroughs as well. Components such as vacuum tubes, transistors, and integrated circuits of ever greater complexity have been successfully harnessed in radios; black and white and color televisions; and tape recorders and VCRs, creating huge markets in every case.

Now, a new generation of products based on optoelectronic technologies is becoming available. These products, which include the compact disc (CD) player and laser vision, have opened entirely new markets which are already growing rapidly. But until the advent of the CD player, the production of laser diodes was relatively low. Only 66,000 were produced in 1982, the year CD players were introduced. In contrast, 8.7 million laser diodes were made in 1986.

Value of the Japanese optoelectronics market is expected to surge



Source: Sanyo Electric

Largely because of the CD's popularity, lasers and optical discs have found their way into an array of additional products. For example, CDs have been adapted for use in the office as a data storage medium. Their first application was as read-only memories (CD-ROMs), but technical refinements have now led to the introduction of recordable and erasable memory systems.

Another office application is the high-definition optical disc video filing system. This product's developers expect it to be used for storing archives of high-quality images in libraries, museums, hospitals and publishing companies. Archival storage equipment for ordinary documents is also on the market.

In the consumer electronics field, CD-video players and interactive CD players appeared not long after the popularity of music CDs was established. One of the most recent products is a laser disc player called the "three in one," which plays three types of discs: CDs, CD-videos and laser vision.

Those examples, however, represent just a small portion of the total market of optoelectronics. In Japan, the market for optoelectronic products was valued at $7.4 billion in 1986, with optical disc equipment accounting for about 30% of that total. The market's value is expected to reach $29.6 billion in 1991, and $88.9 billion by the year 2000. For the next five years, the industry estimates that the growth rate for this market will exceed 30% annually. Estimates of the market growth rate for consumer products using optical discs and laser diodes are even higher.

Any technology, including optoelectronics, can only progress when it is utilized worldwide. To make this possible and to alleviate trade conflicts, Sanyo Electric Company Ltd. has established 75 overseas sales offices and manufacturing plants. One of the newest is the Sanyo Laser Products manufacturing plant in Richmond, Ind. Mutual cooperation not only advances technology, but it also is an essential condition for global prosperity in the 21st century. □

Yamano is executive vice president of Sanyo Electric Company Ltd. and a member of its board of directors.

SEMICONDUCTOR PRODUCTION

America's chip mask makers stage a dramatic recovery

Merchant mask producers have cleaned up their act after realizing that Japanese rivals were waiting in the wings

By Carol Suby

The U.S. semiconductor mask-making industry — in danger of disappearing just a few years ago — is now emerging as a shining example of how a moribund U.S. market can make a comeback.

After wavering in the $400 million range for the past several years, the domestic market for photomasks — photographic glass plates used to transfer circuit patterns onto semiconductor wafers — is growing once again, and is forecast to reach approximately $620 million by 1991, according to research and consulting firm, Rose Associates in Los Altos, Calif. More impressive, however, is the fact that this sector, previously close to expiring from self-inflicted wounds, has been able to make a startling recovery.

Resurgence is thanks to several coincidental factors: growth in the ASIC sector, where more masks are used; the fear inspired in domestic mask makers, and their consequent action, when they saw Japanese suppliers getting orders from major semiconductor houses; prodding by one particularly demanding ASIC vendor; and the emergence, for the first time, of a major domestic mask maker: Du Pont.

Just three years ago, mask prices were in free-fall — some 30% to 50% in a year. Meanwhile, the trend toward smaller geometries on integrated circuits required that merchant mask makers — which averaged between $3 million to $15 million in revenue — purchase state-of-the-art equipment that carried $1 million to $3 million price tags. "Companies that size weren't sure they could justify such an investment," says Jerry Hutcheson, corporate officer at San Jose-based research firm VLSI Research Inc. As a result, he says, "in some cases, they chose to do nothing."

And merchant vendors weren't the only ones feeling the pinch. Amidst the most severe downturn in semiconductor history, internal mask operations were hard pressed for capital dollars as companies cut expenses to the bone. Overall, domestic mask manufacturing suffered. Products became characterized by poor quality. Also, they were not cost competitive nor did they meet customers' cycle time demands. If the U.S. suppliers had continued on this tack, their business may have ended up "almost exclusively in Japan," says A. Travis White, vice president for assembly, test and packaging development at ASIC chip maker LSI Logic Corp. of Milpitas, Calif.

In fact, while U.S. vendors were gasping, Japanese vendors like Dai Nippon Printing and Toppan were just getting into their stride. These two, each under the umbrella of multibillion dollar enterprises, could afford whatever equipment was necessary to do the job right. They were also large enough — together they hold approximately 80% of the total photomask market in Japan — to enjoy economies of scale unmatched by any U.S. firm. During the semiconductor downturn, these offshore companies inked deals with four of the top five U.S. semiconductor houses.

Agents of change

Bit by bit, domestic companies began to react. Micro Mask Inc., based in Sunnyvale, Calif., had been a major supplier to Intel Corp. However, "management in the photomask division didn't keep current or pay enough attention to the demands of the marketplace," says Joseph Ross, chairman and chief executive officer of Micro Mask. Within that same time frame, Intel — which depends entirely on merchant suppliers for its masks — began to do business with Dai Nippon. In reaction, Ross went on the warpath.

Management was replaced, and the photomask division at Micro Mask, "embarked on changing the philosophy and culture of the busi-

Rod Thomas

Center stage again: U.S. mask makers can thank LSI Logic -- and Du Pont

ness, from the president on down to the janitor," says Ross. Meetings were held with people throughout the organization to discuss what was keeping them from being successful, "and then we'd make sure corrective actions were taken within a week," Ross notes. This close attention to improving business from the bottom up, combined with a stronger focus on meeting customer demands — which required spending nearly $9 million in capital equipment during two recession years —helped to turn around the fortunes of Micro Mask. Revenue grew 19% during 1986 and approximately 25% during 1987, according to Ross. Profitability also returned in 1987, according to Ross. In addition, the company has moved up from No. 4 in market share for 1985 to No. 2 for 1987, behind Du Pont's combined Tau Labs and Master Images operations.

Japanese vendors weren't the only ones to shake up complacent mask makers. Others applaud Tau Laboratories Inc. as a merchant vendor that contributed to the turnaround. Headquartered in Poughkeepsie, N.Y., Tau Labs opened a facility in Kokomo, Ind., where it took over the mask operations of General Motors subsidiary Delco Electronics in late 1983. Later, this Kokomo operation began "beating Silicon Valley companies on turnaround times, on price, and on getting things right the first time," says Robert Clary, principal associate with Rose Associates.

The sleeping valley companies began to wake up. And giving them an extra push was ASIC firm LSI Logic Corp., which many in the industry credit for being a major agent of change. Four years ago, LSI Logic went to 26 different mask suppliers and asked for three-day cycle times — the time from when an order is placed to when it arrives at the customer's dock. "They told me I was crazy," says White. Tau Labs, now owned by Du Pont, was the only company willing to take on the job. Today, LSI Logic has four major mask suppliers that can deliver products in less than 26 hours. "Suppliers in Japan, in Europe, can't do that," White points out.

The domestic market for photomasks is growing again and is forecast to reach $620 million by 1991

Another major contribution was the formation of the first domestic mask giant. During the past two years, E.I. du Pont de Nemours and Co., based in Wilmington, Del., purchased the two largest independent mask makers in the United States — Tau Laboratories and Master Images. Du Pont's interest in the photomask market is "a way to participate in the semiconductor industry long term," says David Heilman, vice president, photomask operations, at Du Pont Tau Labs' Kokomo facility. The company's long-term plans include expanding its photomask operations to Europe and Japan with the expectation of becoming a world leader. Now that the United States has a giant company with resources behind it, it has become "a whole new ball game," says Hutcheson of VLSI Research.

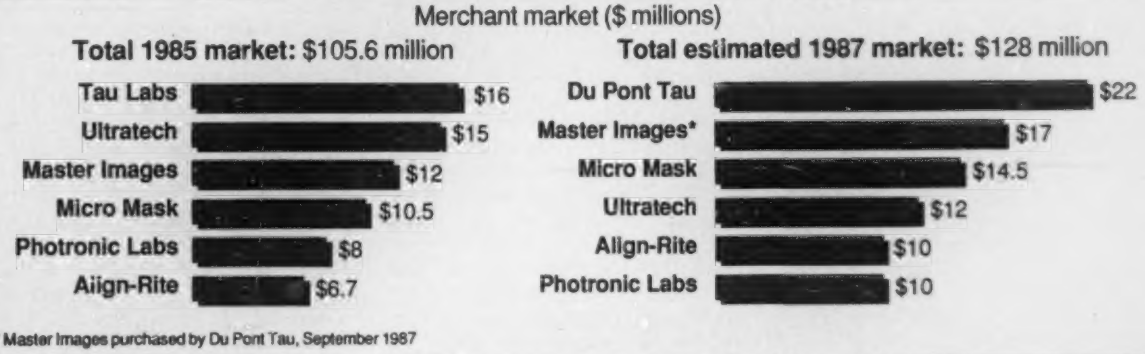
The new ball game also has a new team. The American Photomask Association, formed in 1986, created a forum where mask suppliers, its semiconductor manufacturing customers, and the equipment suppliers could work together to resolve industry-threatening issues, says Steven Wilson, chairman of the association, and sales manager for General Signal Corp.'s Ultratech Photomask operations. Contributing to the association's success is the fact that the world standards for the equipment used to manufacture, inspect and repair wafers are set by U.S. companies. In fact, Perkin-Elmer Corp., based in Norwalk, Conn., holds approximately 90% of the worldwide market for E-beam equipment, which is at the heart of mask making. And the equipment used for wafer inspection comes predominantly from KLA Instruments Corp., based in Santa Clara.

The turnaround

Today, "American photomask suppliers have made a phenomenal readjustment to serving the semiconductor manufacturers," says White of LSI Logic. "Quality is now superb [and] as good, or better than anyplace in the world. In the area of cost competitiveness, they've made dramatic changes." Cycle times, he adds, have also vastly improved. In addition, the tide of foreign competition appears to be stemmed. Japan has never been able to capture any more than 5% of the U.S. market, according to Clary of Rose Associates.

Coincidentally, the growth of the ASIC market in the United States has also contributed to this turnaround.

In the domestic photomask arena, market leadership holds no guarantees



Source: Rose Associates

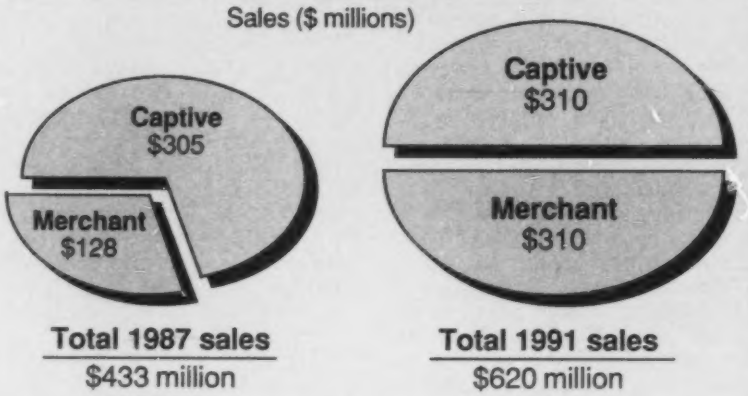
"ASIC companies generally use more photomasks than others," points out Michael Yomazzo, vice president for sales and marketing, for Photronic Labs Inc., a merchant mask maker headquartered in Brookfield Center, Conn. Not only do ASICs require more masks, they are also becoming an increasing portion of the total semiconductor pie. Last year, ASICs represented 16% of the $29 billion worldwide chip market, according to research firm Integrated Circuit Engineering Corp., in Scottsdale, Ariz. By 1992, they are expected to grow to 22% of a $48 billion market.

While U.S. suppliers of photomasks are once again on a competitive bent, that does not mean they can now rest easy. Mask makers lead a draconian existence. Austerity is key in an industry that must spend heavily to stay alive. According to Micro Mask's Ross, it will, with the new generation of E-beam equipment, require about $7 million in investment to generate up to $11 million in sales. One ingredient for survival, says Wilson of the APA, is "to drive the cost of manufacturing way down. Those who are successful will stay in business. Those that can't, will go out of business."

Indeed, many captive suppliers, suffering from budgetary neglect, are closing down all or portions of their internal photomask shops. For example, Motorola Inc.'s Austin, Texas, photomask operations were taken over last year by Du Pont Tau Labs. (However, Motorola continues to invest in and operate its Mesa, Ariz., photomask facility.) Gould AMI Semiconductor, Santa Clara, sold off its mask operations — Advanced Micro Images — to Du Pont Tau, which moved the equipment and businesses to other locations and ceased AMI operations. Also during 1987, Signetics Corp., Sunnyvale, Calif., closed down its photomask operations and now relies entirely on merchant suppliers. Most in the industry expect that even more captive operations will be sold off or shut down over the next year.

This particular trend, however, translates into more business for the merchant vendors. In fact, Clary of Rose Associates estimates that by 1991 merchant vendor revenue will represent about 50% of the estimated $620 million domestic market. (Today, the revenue is split approximately 2-to-1 with captive shops representing the majority.) A big question mark remains, however, regarding who will survive until the 1990s in the photomask arena. But the disappearance of some players is not necessarily bad for any market. Because of all the competition, the return on investment just isn't there, says Kenneth Wishnuff, director of lithography for the semiconductor division of National Semiconductor Corp., in Santa Clara. "Maybe we need for some companies to go away," he adds.

Merchant mask makers are picking up the business that captive suppliers are shutting down



Source: Rose Associates

Although consolidations are expected to continue for the next several years, other companies are expanding. Align-Rite International PLC — the British holding company for Align-Rite Corp. in Burbank, Calif. — is involved in a $35 million five-year expansion plan. The company began its European operations in Wales in September 1985. An additional facility is expected to begin operations by the first quarter of 1989 in Nijmegan, the Netherlands, according to James MacDonald, president of the Burbank facility and chairman of the holding company. Align-Rite is the only mask maker with multinational manufacturing facilities, says MacDonald. The company is also exploring the possibility of opening up a facility in the Far East. And, according to MacDonald, Align-Rite is likely to become involved in the acquisition process in the near future.

By 1991, merchant vendor revenue will represent about 50% of the domestic mask market

Photronic Labs is also in an expansion mode. Over the past few years, Photronic has spent more than $15 million on capital expenditures, most of it going to its newly opened photomask facility in Milpitas, Calif.

The No. 1 player, Du Pont, might have future acquisition plans, but the goals for 1988 are quite basic. With facilities in New York, Indiana, Texas and California, the major challenge for 1988, says Heilman, is getting all of the operations coordinated and "tied together as a team, so that the various locations become transparent to the customer."

Indeed, serving the customer is the main focus for all of the photomask players, especially at this time when customers are paring down the number of suppliers they use. There is a question of how much expansion can be managed before a company suffers from being spread too thinly. As a result, not everyone is in a geographical expansion mode.

The strategy at Micro Mask, "is to keep to one location, work like hell, and grow," says chief executive Ross. Despite growing at a faster rate than the overall market in terms of revenue, the total number of customers Micro Mask is serving has declined. But this is "by design," declares Ross.

Currently, approximately 75% of Micro Mask's business comes from five major customers, while the total number of customers beyond that has shrunk considerably. "We concentrate on developing a roster of customers with whom we can expect up to $1 million in business a year," says Ross. The company is now looking to add two to three more such customers to its roster while cutting down on servicing those that have minimal needs. □

SUPERMINICOMPUTERS

Did super sales of '87 mark a supermini peak?

Competition from microprocessor-based systems clouds the outlook. Who will get crushed by the Unix bandwagon?

By Mary Jo Foley

To many vendors, the minicomputer market has been a kind of final frontier. It is the one major computer segment least dominated by IBM, and its high-end, or supermini, portion has hospitably accommodated diverse players targeting markets ranging from on-line transaction processing to seismology. The strong and steady sales exhibited by most supermini participants in 1987 — despite the lack of major hardware introductions — has led many to believe that departmental computing will continue to provide solid opportunities in the foreseeable future.

And, indeed, nearly every supermini vendor is calling for 1988 to be a banner year. However, a growing number of market watchers is predicting that 1988 may prove to be less profitable than expected for many supermini makers.

At the high end, Digital Equipment Corp. is expected to unleash at least one major new product, dubbed the vector-VAX, along with a parallel-processing version of its VMS operating system. At the lower end of the midrange market, IBM is slated to debut its long-awaited "Silverlake" — an amalgamation of its current System/36 and System/38 minicomputer lines. In between, other vendors are expected to continue to shore up and replace their existing product families.

The importance of standards — in particular, the Unix operating system — is on the rise. This is good news for the many start-ups, second-tier vendors, and handful of brand-name players, led by Hewlett-Packard Co. and Unisys Corp., which have embraced Unix. It may spell trouble for other companies, including DEC and IBM, which offer Unix as a second or third choice to their proprietary operating systems.

As if all this were not enough, a new generation of microprocessor-based systems, including systems based on the new Motorola Inc. 32-bit processor, are expected to be launched as competitors to existing systems in the coming year. "By the end of the decade, the new buzzword will be microprocessor-based systems," according to International Data Corp. midrange systems analyst Christopher Hallgren. As a result, "traditional vendors will need to become software vendors and/or sell much cheaper hardware" in order to survive, he claims.

Nearly every supermini vendor is calling for 1988 to be a banner year

In spite of these confusing trends, several industry watchers are predicting continued strong supermini sales for the market as a whole. Framingham, Massachusetts-based IDC estimates that worldwide shipments of midrange computers by U.S.-based vendors reached 37,000 in 1987, and should hit 44,200 in 1988. (IDC generously defines "midrange" as systems costing between $100,000 and $1 million, usually configured for 17 to 128 users. This definition includes many "traditional" minicomputers, as well as many of the minisupers now on the market.) The dollar value of this market will grow roughly 8.8%, IDC adds, from $16.2 billion last year, to $17.62 billion in 1988.

But not all industry gurus are calling for smooth sailing. "It may be this product category [superminis] is starting to age, as categories above and below are eclipsing it," suggests Gregory Kosinski, an analyst with Dataquest Inc., of San Jose. "There will continue to be growth [in superminis], but nowhere near as dramatic as at the other two ends of the computer spectrum."

Some market watchers are even more severe in their predictions. "It is our opinion that the [mini] computer systems business is on the verge of major secular change," says John Levinson, an analyst with New York City-based Goldman, Sachs & Co. "The vendors that could be most negatively affected in this new environment are, in fact, those that benefited the most from the ways of the past," he says, namely, Data General

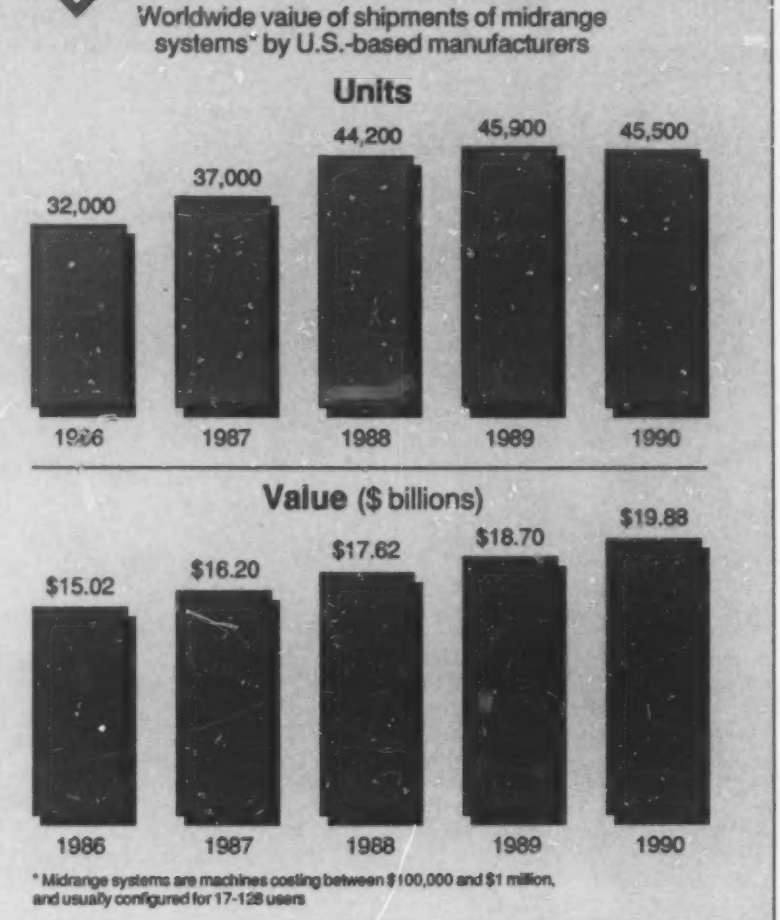
Marty Braun

Corp., DEC, IBM, Prime Computer Inc., Unisys, and Wang Laboratories Inc. Those which are best suited to adapt to the emerging midrange world — where integration, standards, competitive microprocessor-based systems, and self-service (as opposed to vendor-provided service) are key — are companies such as AT&T, Hewlett-Packard, Ing. C. Olivetti & Co., Sequent Computer Systems Inc. and most of the European-based computer vendors. And those which promise to be the least affected by the changing minicomputer environment, mostly as a result of their specialized niche strategies or current strategies which take the new integration, interoperability, and standardization requirements into account, Levinson claims, are NCR Corp., Siemens AG, Stratus Computer Inc. and Tandem Computers Inc.

Vendors still optimistic

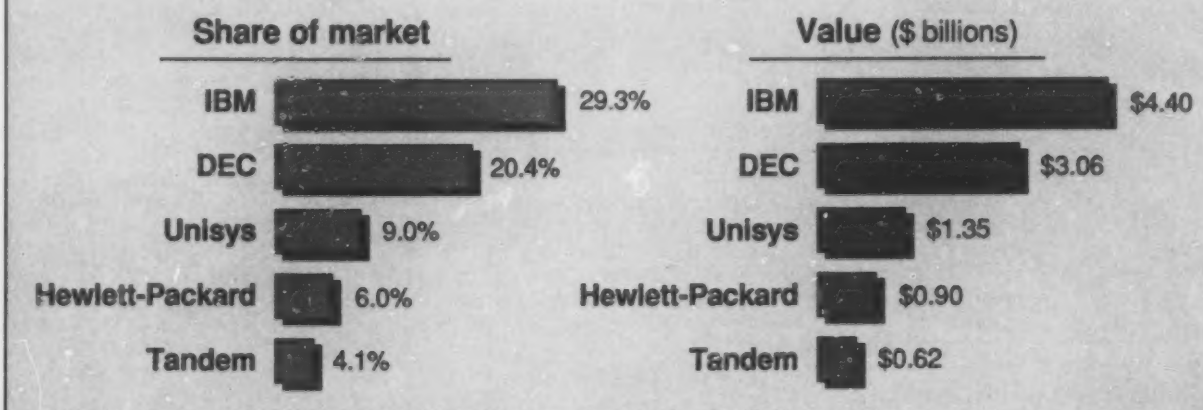
Most analysts agree that, by far, most of the demand for midrange systems in 1988 will come from companies that already have deployed departmental solutions. The Sierra Group, a Tempe, Ariz. market researcher, found that more than half of the 1,045 U.S. companies which it recently surveyed, with annual sales ranging from $10 million to $3 billion, planned to purchase minicomputers during the coming year. In its surveys, IDC has found midrange computer buyers to be split fairly evenly between commercial- and sci-

Superminis: Steady as they go



Source: International Data Corp.

DEC runs a close second to IBM in superminis



Source: International Data Corp.

entific/engineering-oriented concerns; by the end of the decade, the latter customer group will grow at the expense of the former, the market researcher says.

However, just because spending is on the rise does not mean all vendors can count on a bigger piece of the midrange pie. "The departmental minicomputer market has entered the first stages of a zero-sum marketing game, and one that will favor only a handful of industry suppliers" — namely, the incumbents, claims Sierra vice president Marty Gruhn. According to IDC, in 1986, when the midrange market totaled $15.02 billion, these "incumbents" included: IBM, with 29.3% of the total market revenue; DEC, with 20.4%; Unisys, 9%; Hewlett-Packard, 6%; and Tandem Computer, 4.1%.

In order to continue to thrive, all vendors, entrenched and not, will need to pursue a two-pronged marketing strategy, Gruhn contends. First, they will need to capture new accounts over the next 12 months; secondly, they must reduce competitive inroads by offering consistent upgrades and enhancements to their installed bases. Yet, even if companies follow these guidelines, she cautions, "it is not clear that a high level of demand will emerge in these organizations in the future."

In spite of analysts' somewhat pessimistic predictions, most vendors claim they are expecting strong supermini sales for at least the next few years. IBM, for one, should benefit from accelerated shipments of its 9370 systems. Despite the dearth of applications software required by the small- to medium-sized companies and departments at which the machines are targeted, Big Blue was expected to have shipped 5,000 by the end of last year, according to IDC. IBM could sell another 15,000 9370s in 1988, if demand continues at its current pace, IDC calculates. In anticipation of continued strong sales, IBM expanded its base of resellers by 20% in 1987, and reportedly is expecting to expand by another 20% this year. Additionally, increased availability of all types of midrange software is a top priority for IBM's newly created Applications Systems Division.

Salesforce catches on

Third-ranked Unisys is also expecting to do well in 1988, and industry watchers expect the same. "Our salesforce is finally getting to understand our projects and the merger," says Curt Koster, program manager for entry- to midlevel systems for the Detroit-based company. Unisys' "superminis" include systems ranging from its low-end A series through its various Unix products. Koster, responsible for the Series 1100's 2200 family, says he expects the ability of the 2200 models to serve as development and/or delivery machines to serve them well in the ongoing "departmental computing explosion." In order to move beyond Unisys' installed base and capture new customers, the company will play on its "industry leads in connectivity and distributed environments," especially in terms of its strength in standards and fourth-generation languages, he explains.

Just because spending is on the rise does not mean all vendors can count on a bigger piece of the midrange pie

"The supermini market is an example of a technology-driven market driving price down," Koster says. "And we're driving the technology there."

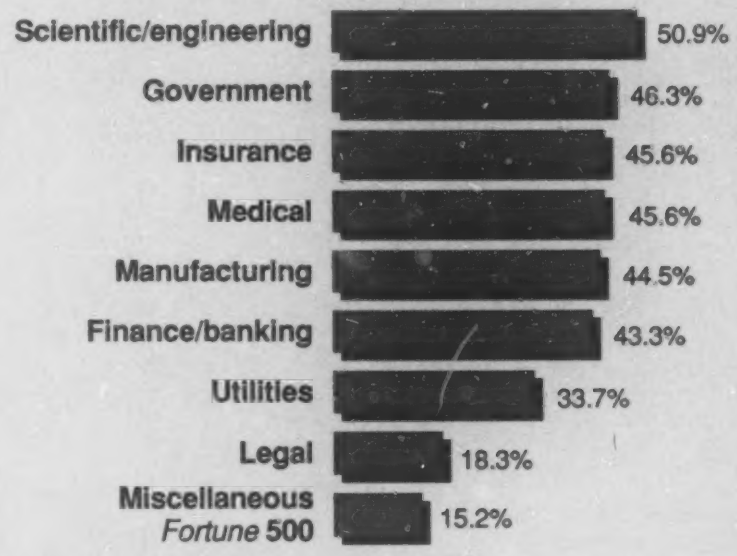
Hewlett-Packard, despite delays in shipping its HP 3000 Model 930 RISC (reduced instruction set computer) machines, says sales are strong for all six of its recently introduced architectures and expects the brisk demand to continue. Total revenue contributed by all of the Cupertino, California-based company's 3000 computers, in fact, rose 18% from 1986 to 1987, according to Linda Lazor, product line manager for future HP 3000 products. Sales of the high-end Model 950 and midlevel Series 70 were especially strong last year, she reports.

"HP this year and next are the ones to watch," IDC analyst Hallgren agrees. "If they can manage to sell outside their customer base, they should do very well."

The company is counting on its strategy offering MPE (HP's proprietary transaction-processing-oriented operating system) along with HP/UX (Unix) to help it penetrate a variety of new accounts, Lazor says. "We will have lots of stuff coming out next year, ranging from networking to office [software] products to systems," she says. "We're starting to see our huge investments [in the new Spectrum architecture] pay off," she claims. "We now have the ability to bring out leadership products in a variety of platforms." □

Supermini spending to rise

Percentage of companies expecting to increase minicomputer spending in 1988



Total survey base = 1,045 companies

Source: The Sierra Group

DATABASE

Most signals positive

Growth of new orders for computers and office machinery are on a fast track. On a seasonally adjusted basis, October new orders rose $271 million, or 5.5%, from the level in September. This increase brought the monthly total to $5.2 billion, 20% higher than the same month in 1986. New orders will grow rapidly through the third quarter of 1988.

Industrial production of computers and office machinery rebounded in September from the setback experienced in the prior month. In October, output rose an additional 1.5% on a seasonally adjusted basis. Through the third quarter of 1987, average production was running 4.1% above the average for the first three quarters of 1986. Shipments of $5.0 billion in October brought the total for the first 10 months of 1987 to $47.2 billion, 1.8% higher than the comparable period for 1986. From the end of 1987 through 1988, shipments will grow by over 15%.

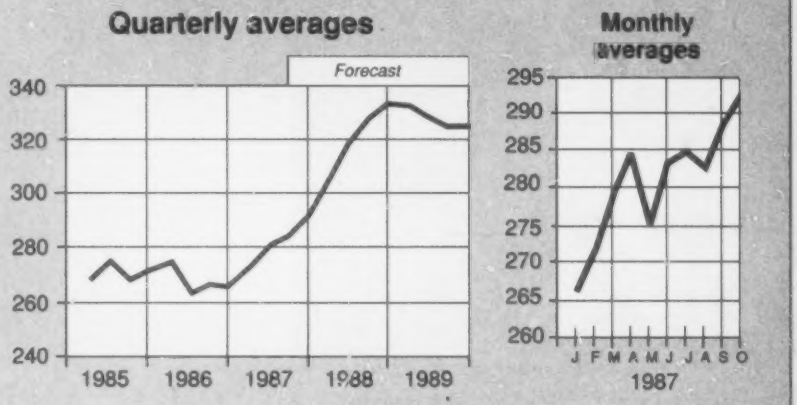
Exports of office and computing machines tallied $4.6 billion for the third quarter of 1987, a 19% increase relative to the third quarter of 1986. However, imports grew at a faster clip, up 31% in a third quarter to third quarter comparison. At $4.9 billion, imports outpaced exports by $262 million.

Edited by LINDA STALLMANN

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, MA 02158 Phone: (617) 964-3030.

Industrial production index for computers

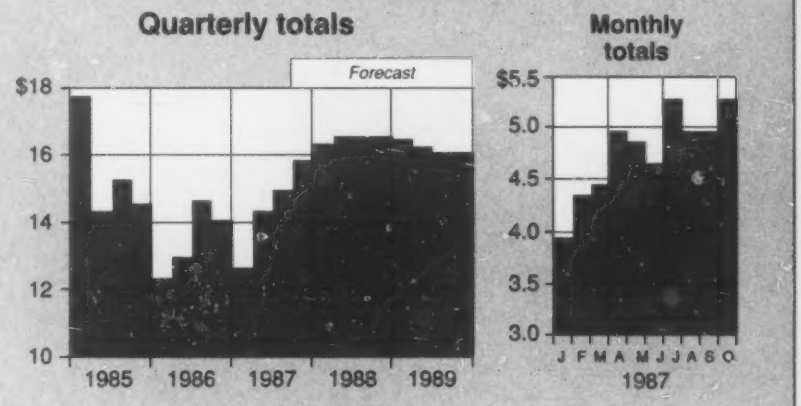
Seasonally adjusted index (1977=100)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

New orders of computers

Seasonally adjusted (Current $ billions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, September)	292.4	288.2	+1.5%	265.5	+10.1%	333.6	+14.1%
Shipments (SA, $ millions, October)	$5,047	$4,966	+1.6%	$4,594	+9.9%	$5,765	+14.2%
New orders (SA, $ millions, October)	$5,174	$4,903	+5.5%	$4,311	+20.0%	$5,509	+6.5%
Unfilled orders (SA, $ millions, October)	$19,322	$19,195	+0.7%	$19,068	+1.3%	$21,087	+9.1%
Inventory-to-shipment ratio (SA, October)	1.89	1.91	—	2.22	—	1.88	—
All employees (thousands, October)	459.3	457.6	+0.4%	465.3	-1.3%	492.4	+7.2%
Production workers (thousands, October)	151.4	150.9	+0.3%	154.6	-2.1%	159.9	+5.6%
Exports ($ millions, September)	$1,730	$1,482	+16.7%	$1,349	+28.2%	$1,664	-3.8%
Imports ($ millions, September)	$1,708	$1,589	+7.5%	$1,170	+46.0%	$1,711	+0.2%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

The politics of high tech in China

Preliminary signs indicate there may be a mini-boom in the offing

By Al Furst

After two quiet years of relatively modest sales in China, American high-tech companies may finally be able to look forward to an upsurge in business activity during 1988. Like everything else in China, the reasons are part political and part economic.

First the economic reasons. A number of U.S. electronics manufacturers — including Hewlett-Packard Co. and John Fluke Manufacturing Co. — report that the number of inquiries about prospective purchases are up this fall. A rush of such inquiries usually precedes a buying spree.

Traditional Chinese spending patterns reinforce this tendency. Like many Communist countries, China runs its economy on a five-year plan. This year will be the third year of the current plan, and that's when — as one U.S. executive told me recently — "the Chinese like to turn on the spigot."

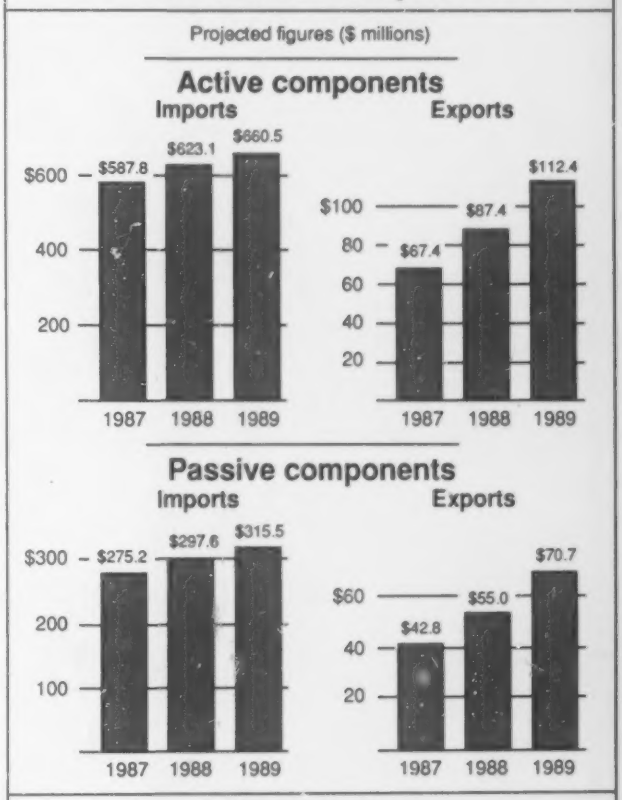
The spigot could open all the way, too, because Chinese factory managers typically squirrel away funds for a few years while they compare wares and shop around for the best buy in computers and other foreign-built equipment. Just like governnment contractors in the U.S., it's "use it or lose it;" if they don't spend the money that's been allocated to them from above, they know that those funds could disappear forever. And that's a powerful incentive to buy — even though China is still plagued by shortages in foreign currency.

The political timing for mini-boom in high tech is also right, barring unforeseen difficulties — such as China's inability or unwillingness to halt shipments of Silkworm missiles to Iran.

The new young, reform-minded leadership which swept into power last fall under Deng Xiaoping's protege, Premier Zhao Ziyang, includes some important allies of the American high-tech community. The most notable is Li Tieying who, at 51, is now the youngest member of the ruling 18-member Politburo.

China: The market for electronic components

Projected figures ($ millions)



Source: A.T. Kearney Inc.

Tieying, who is also the Minister of Electronics, has visited the U.S. several times in recent years at the invitation of the American Electronics Association, a trade association based in Santa Clara, Calif. Time and again, Li impressed his American counterparts with a willingness to listen seriously to their numerous complaints about government bureacracy.

The rise of technocrats like Li, as well as the anticipated resurgence in high-tech purchases next year, bodes well for computer and electronics manufacturers — both in Silicon Valley and along Boston's Route 128 technology highway. □

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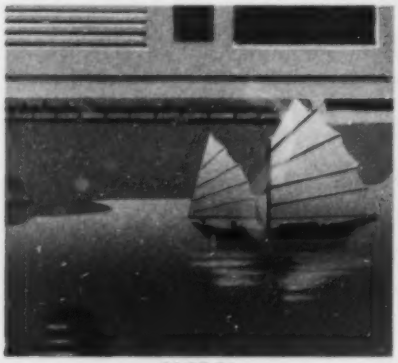

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VBPA ABP

Can computer production keep growing this year?

Apple and Sun, are going strong. But chip supplier Motorola sees signs of slowing growth

Few people have their wet finger up in the computer business winds like Doug Powell, the marketing director at Motorola Semiconductor Products Division, who is reponsible for watching the computer market. Powell, a former computer designer himself, must anticipate which chips computer companies may buy in the future, and how many.

The connection is strong because computers are the major market for U.S. chip makers. At every business cycle, semiconductors have led computers by six to nine months. During the last cycle, shipments of semiconductors to the U.S. market peaked in the third quarter of 1984, whereas the Federal Reserve Board's industrial production index for "computers and office equipment" (SIC 357) peaked three quarters later. In 1985, U.S. computer makers were still shipping their products, but were not buying many chips because orders from their customers had already fallen off.

So far, production of computers and sales of semiconductors are doing very well. The FRB's industrial production index ended 1987 on a very strong note. After passing the 1984 peak in the second quarter, the index closed 1987 up 9% for the last quarter and 5% for the year. Cahners' senior economist Elizabeth Baatz expects the production index to continue growing smartly this year. She forecasts that 1988 will be up 14%, with the index peaking in the last quarter, remaining even in the first quarter of 1989, then sliding down gently but still closing down the year up 2% over 1988. Similarly, market research firm Henderson Ventures forecasts 13% growth in 1988, but its view of 1989 is for 8%, more bullish than Baatz's. Semiconductor sales, on the other hand, may have peaked already in the third quarter of last year, although they seem to have held close to that peak level in the fourth.

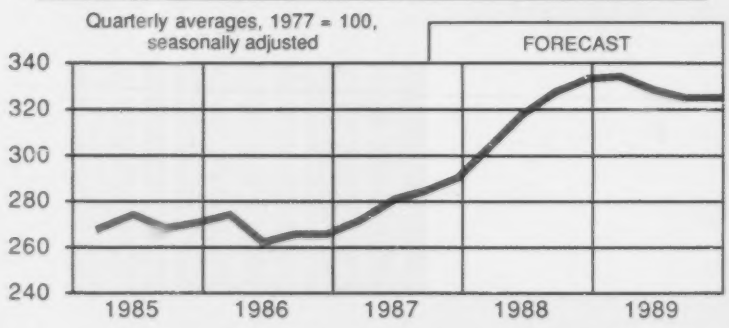
Most of the growth in computers has come from its two price ends — personal computers and supercomputers. Sales by key companies, weather vanes to business winds in the low end, such as personal computer pioneer Apple Computer Inc. and hard disk technology leader Maxtor Corp., were up almost 50% in 1987. Sun Microsystems Inc., *wunderkind* of workstations, nearly doubled its sales in the calendar year. At the high end, sales by supercomputer leader Cray Research Inc. were up 15%. Most of the production and value added by these companies takes place in this country, thus contributing to the FRB's industrial production tally.

Apple's and Sun's most successful computers are based on Motorola's 68000-series microprocessors. But Powell already discerns some signs that growth in that business may slow down sooner than the forecasts suggest. He claims that manufacturers of small computer systems have ordered enough hard disks and other peripherals for their 1988 production, and may pare down their inventories this year.

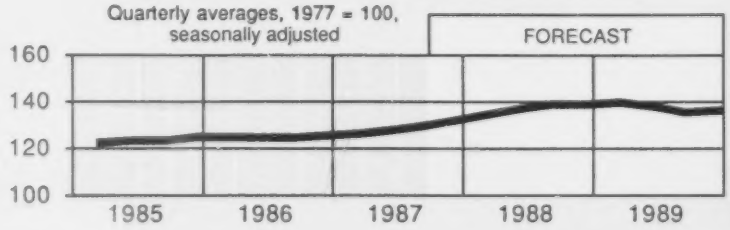
ALBERTO SOCOLOVSKY

Computers and office equipment (SIC 357)

Computer and office equipment production index



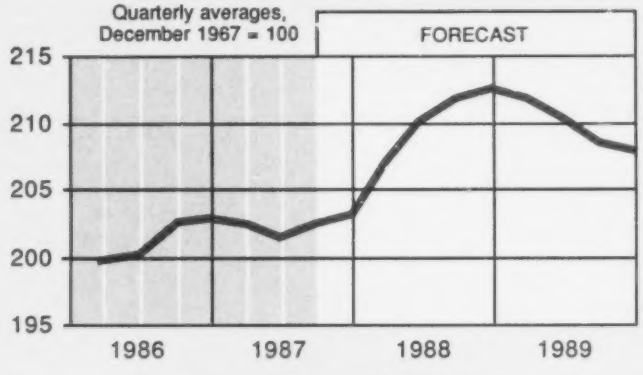
Total U.S. industrial production index



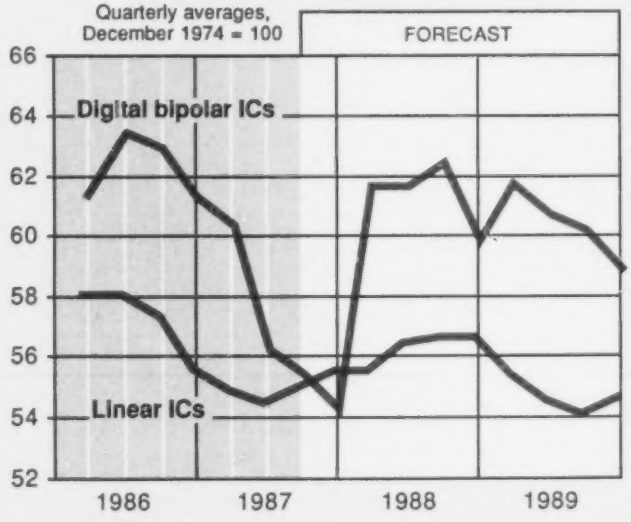
Historical data: Federal Reserve Board; Forecast: Cahners Economics

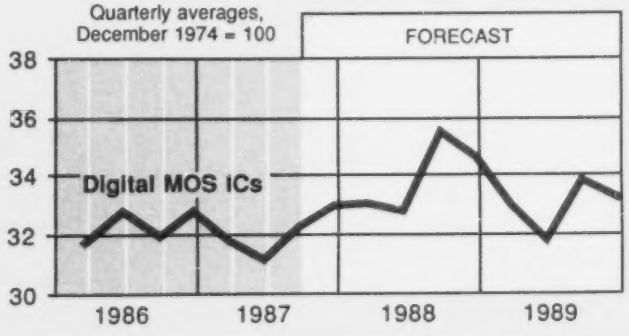
Producer price indexes

Electronic components and accessories (SIC 1178)



Active components





Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic components
Prices of most types of electronic components continued to weaken in the fourth quarter of 1987, according to the Bureau of Labor Statistics. In the fourth quarter, the producer price index for all components rose 0.2% above year-ago levels. The annual increase for components in 1987 was 0.5%, the lowest price rise since 1976. A lengthening of delivery times and rising import price pressures is expected to lift prices up about 4% this year, says Cahners Economics. Still, compared to the early 1980s and 1970s, this price rise is modest. The wage-inflation link of the 1970s appears to be broken and commodity markets are still depressed. So inflation will not be the buzzword this year.

Digital bipolar ICs
Producer prices of digital bipolar ICs have fallen every quarter since the spring of 1986 and they fell again in the last quarter of 1987. A fourth quarter 11.6% year-ago drop pushed this components annual producer price index to its lowest level since mid-1983. Prices of this product are typically volatile: they rose 20% in 1983 and plummeted 21% in 1978. With demand expected to pick up this year and leadtimes stretching, Cahners Economics forecasts digital bipolar prices will rise 8.6% in 1988.

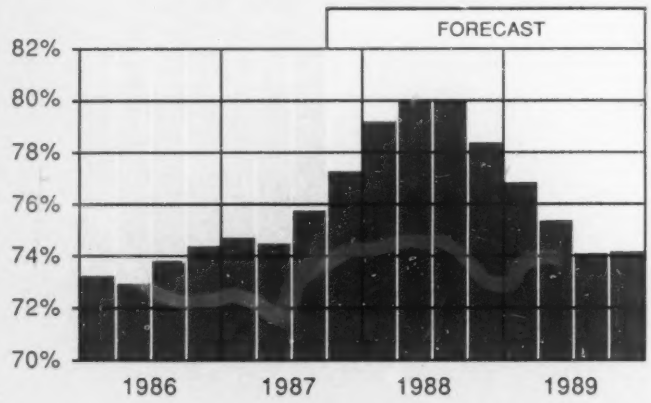
Digital MOS ICs
A 0.5% gain in the final quarter of 1987 from a year ago was not enough to stem the general deflationary trend for digital MOS IC prices. For 1987 as a whole, MOS prices fell 0.9% on the heels of a 10% drop in 1986 and an 18% decline in 1985. Leadtimes, the time between placement and delivery of an order, for all digital ICs rose slowly in 1987, rising just 0.7% after a sharp drop in 1986. Obviously, the delicate supply-demand balance is holding relatively calm so far. The outlook, however, is an 8.6% price increase in digital bipolar ICs this year, before prices are slashed once again in 1989.

Linear ICs
Prices of linear ICs fell just 0.1% in the fourth quarter of 1987, compared to a year earlier. Overall, linear IC producer prices dropped 4% in 1987, continuing the deflationary trend established in the past two years. Leadtimes also dropped significantly in 1987, suggesting that excess supplies are available. So rising price pressures will be least severe for this product. Cahners Economics expects linear IC prices to accelerate just 2.4% in 1988, followed by another 2.9% price drop the following year.

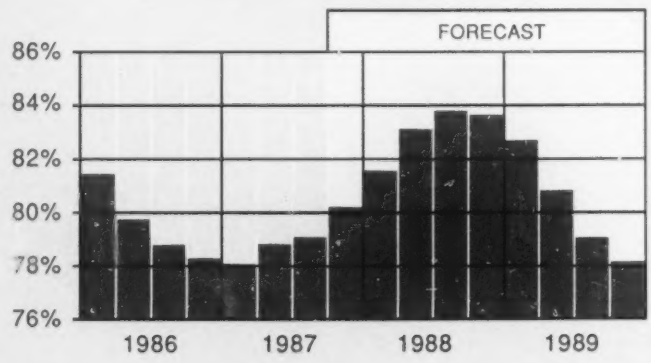
Plant utilization

Average percentage of capacity utilized per quarter, seasonally adjusted

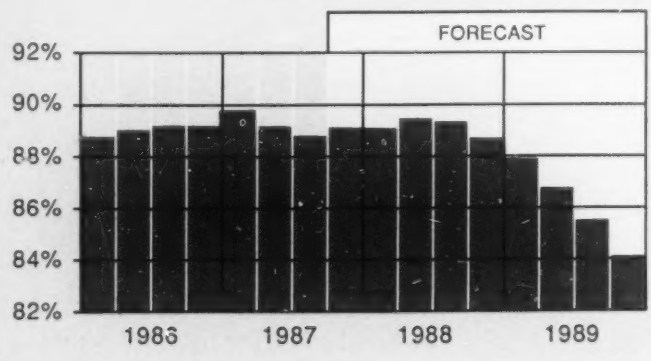
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical and electronic machinery operated at an average 75.7% of capacity during the July through September period, up from 74.5% in the second quarter of 1987. This industry is forecast to increase new plant and equipment spending in 1988, up 7.5% over last year, as new capacity is needed to keep up with rising demand. Production is expected to jump over 8% this year, which will in turn push operating rates up 4% by midyear. Manufacturers will easily operate above their 20-year average of 78.2%, but will stay just below the peak rates achieved in 1984.

Instruments

The factory operating rate of the instruments industry has been rising, from 78.2% in the first quarter of 1987 to 78.8% in the second quarter, and up to 79.1% in the third quarter. Increased demand for instruments, particularly those to ensure quality, will increase production and put pressure on current plant capacity. Operating rates will edge closer to the industry's 1967-1986 average of 83.2% and will surpass this rate by the end of 1988. However, because the current expansion is more muted than the last, the operating rates will remain below the peak level of 85.6%, hit in the boom year of 1984. Expect utilization rates to drift downward to the 78% to 79% range by the end of next year.

Aerospace

Capacity utilization for aerospace manufacturers is diminishing. The third quarter average of 88.9% was down from the 89.8% recorded for the first three months of last year. The production outlook for aircraft, missiles and parts is in sharp contrast to the recovery in other industries. Growth in factory output peaked in mid-1986, while most industries were in the midst of a slump. The tables will turn by the end of 1988, however, as the aerospace industry feels the pinch. Record high backlogs of $149 billion at the end of October will provide a production buffer in 1988, but with several defense procurement programs completed and no new programs in the pipeline, operating rates will drift downward through 1989.

MATERIALS

Latter-day laminates: fewer makers, but better quality

Circuit-board makers may soon have an improved product to work with as their suppliers of laminates merge

There are no longer as many companies making materials for printed wiring boards. But the ones that are left are bigger, and tl·ey're stepping up investment in the sector. The result? Users should see higher quality products.

Consolidation has been particularly evident over the past several years in the laminates industry, the largest sector of the printed wiring board materials business. U.S. electronics producers used $781 million worth of laminates in 1987, accounting for more than half of the $1.3 billion total U.S. PWB materials market, according to Strategic Analysis Inc. of Reading, Pa.

Not so long ago, the laminates industry consisted of giants General Electric Co. and Westinghouse Electric Corp., at the one extreme, and a host of small companies at the other. Some in the industry suspected the giants of not paying much attention to the tiny and unexciting laminates business. But the small producers were short on capital and had trouble just surviving through cyclical downturns, to say nothing of maintaining heavy investments in next-generation products.

Now, consolidation has brought a whole new lineup of more evenly matched players. The $2 billion British conglomerate Cookson now owns Polyclad. Allied-Signal Inc. bought Norplex, which had itself just acquired Oak. Westinghouse folded in Fortin. Hercules Inc. purchased Mica Corp. And $585 million Bairnco Corp. is building a portfolio of laminates firms, starting with its acquisition of Howe and the Cuclad product line from 3M Co., now known as Keene Technologies.

"Consolidation is making the competition more even," explains Donald Pucci, vice president for technology at Hadco Corp., a leading producer of printed wiring boards and a major user of laminates, located in Salem, N.H. "We will have five to seven really major league suppliers, and that will be good for us in quality, if not so much in price. Before, people undercut each other in price so much they couldn't survive. Now they will maintain prices and work on quality and engineering. They'll be able to spend for more and better engineers."

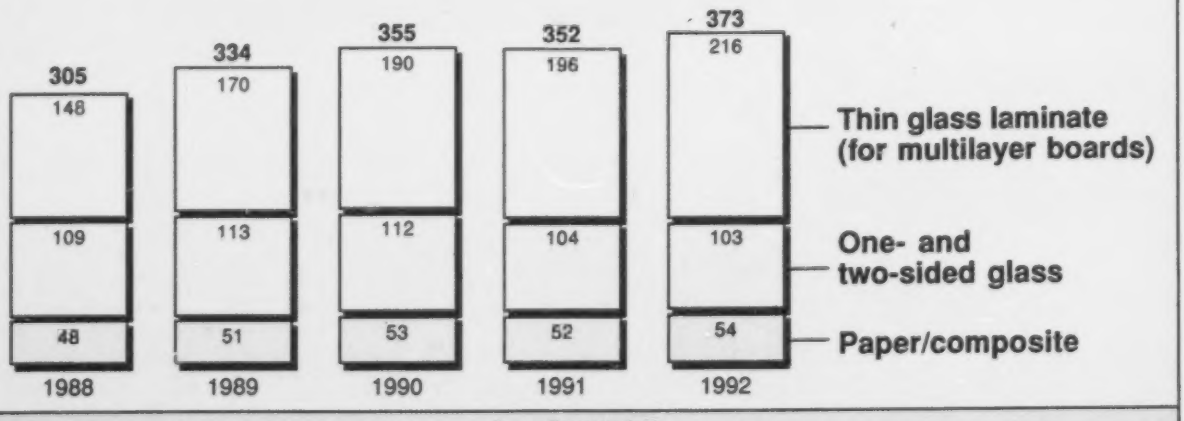
"Now the industry will survive — it's getting critical mass," points out Richard Hurlbut, manager for marketing and sales for GE's electromaterials department, which makes GE's laminates in Coshocton, Ohio. Hurlbut adds: "It could easily have disappeared."

Largest of the reorganized players is Allied-Signal's Norplex/Oak Inc. Norplex and Oak were each already among the biggest of the small fry. Now they make up a $350 million division of a $12 billion corporation. With Oak, Norplex added important manufacturing sites in Asia, backward integration into resin and copper foil, and new flexible and microwave laminate products. With Allied, it added deep pockets.

"Our capital expenditures now are four times what they were at Norplex alone," says David Verbeten, the company's director for product marketing. "We'll be spending $20 million to $30 million a year." Investments will go for more sophisticated new equipment which can be controlled more definitively for tighter

Thin glass laminates for multilayer boards will be in hot demand as the sparkle goes off one- and two-sided glass

Rigid laminate consumption in North America (millions of square feet)



Source: Rose Associates

tolerances and environmental controls. Another big chunk of spending will go toward making the cleaner materials needed for producing extremely fine circuits. Currently, about 25% to 35% of capital spending goes for clean materials. In years to come, the company estimates that figure will grow to as much as 60% to 65%.

"Our R&D spending has increased dramatically," Verbeten adds. "About 20% of our investment expenditure will go for R&D." The company is building a new $3 million R&D center at its headquarters in La Crosse, Wis., and is undertaking joint projects in basic materials science with Allied-Signal's laboratories.

"Norplex is the industry leader in technology," notes Daniel Rose, of materials consulting firm Rose Associates in Los Altos, Calif. "They run the business as a high-technology business and they want to stay in it. When [Allied chief executive Edward L.] Hennessy ordered his troops to sort through Allied's portfolio, the dogs — including many electronic materials companies — went to Henley [an independant spin-off of Allied]. But he kept Norplex. That's a great vote of confidence."

Polyclad executives say their research spending will also increase now that the $100 million Franklin, New Hampshire-based laminate maker has a new $2 billion parent. But only a few months into the marriage, budgets have not yet been set. "The acquisition," notes Polyclad vice president for marketing Richard Costello, "will give us the financial strength to expand or acquire, to more rapidly achieve our five-year plan, which is to double our sales."

There's apparently more industry rearrangement to come. "Consolidation will accelerate," asserts Arthur C. Williams, vice president for international marketing for Keene Corp., Bairnco's laminates subsidiary. Williams adds:"But then I'm in the unique position of making my prediction come true, because I'm going to do it. My job is to buy companies. Many small companies in these businesses are hitting the wall as we move to extremely fine lines and fine circuits. In order to just stay in the game they have to go back and bet the house again, for things like computer driven presses and clean rooms that we didn't use five years ago."

Keene is shopping for more $10 million to $20 million niche businesses to add to its already acquired polyimide and fluorocarbon film lines. Similar to how Bairnco operates in other businesses, the idea is to combine a number of smaller companies in a field, keep the management, bring in more sophisticated marketing and financial disciplines, expand the business to $100 million to $200 million in annual sales, and then spin it off to its shareholders.

U.S. electronics producers used $781 million worth of laminates in 1987, accounting for more than half of the U.S. PWB materials market

Users should benefit as these more balanced competitors turn their attention to quality improvements. "The biggest trend I see," notes Jonathan Avins, a consultant with Strategic Analysis, "is that users will become more critical of existing products and demand higher quality, higher value added."

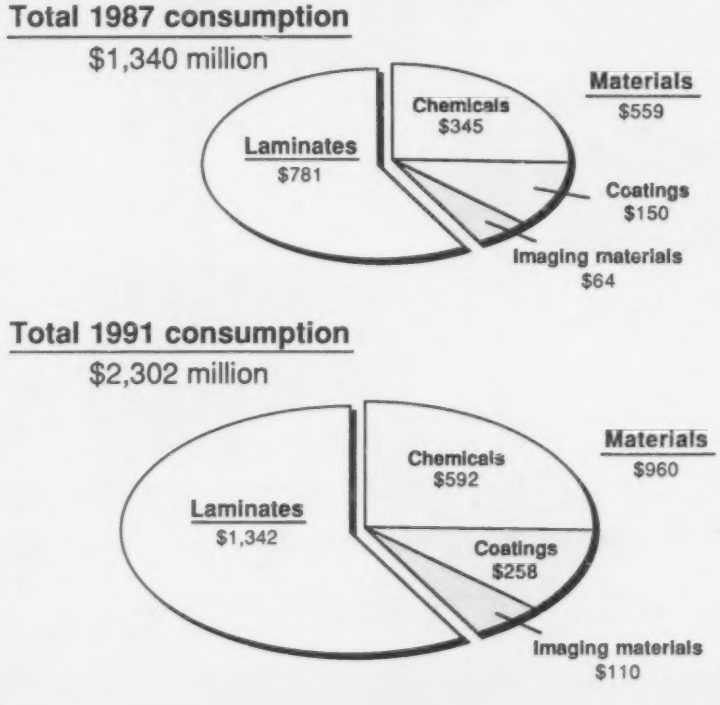
First on the users' wish list, according to consultant Rose, is getting the epoxy formulation under control so that the printed wiring board doesn't warp. The thin layers in multilayer boards shrink or grow unpredictably when processed, making it difficult to keep the layers aligned when drilling tiny holes. "The major issue in our mind is dimensional stability," says Hadco's Pucci.

That issue has yet to be resolved. "There could be an entrepreneurial solution, but probably the entrepreneur wouldn't know what to do with it," adds Pucci. "Most likely, a big company will solve the problem."

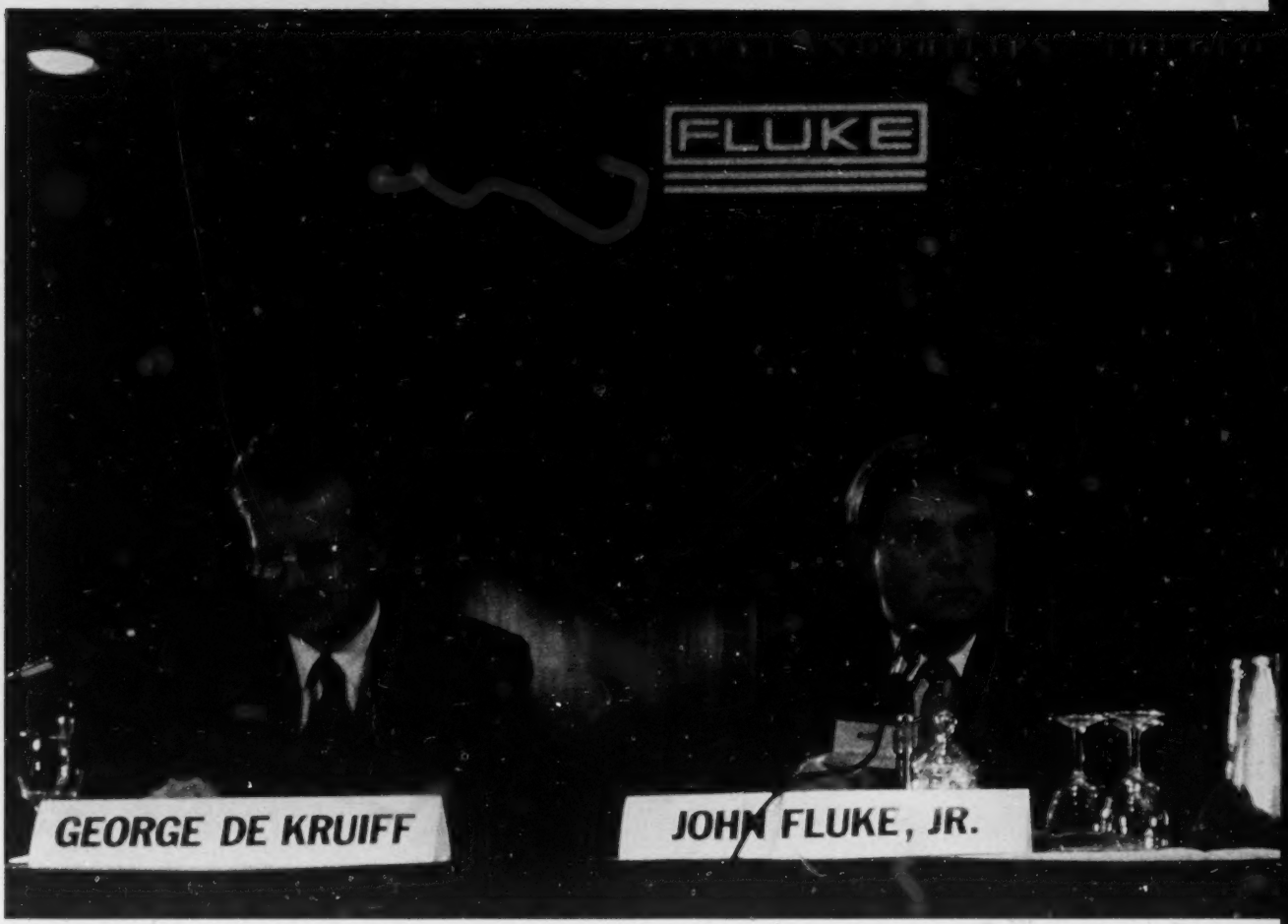
PAULA DOE

Laminates dominate printed wiring board materials market

U.S. consumption, merchant and captive ($millions)



Source: Strategic Analysis Inc.



THE GEORGE, JOHN, BILL & GEORGE SHOW: chairman John Jr., CEO Winn are joined on the board of the new-look Fluke by Philips

TEST & MEASUREMENT

Fluke/Philips:

The combo may team on manufacturing too

Dutch giant Philips' stake in John Fluke Mfg. makes a strong No. 3 in the instruments market. So why aren't HP and Tektronix impressed?

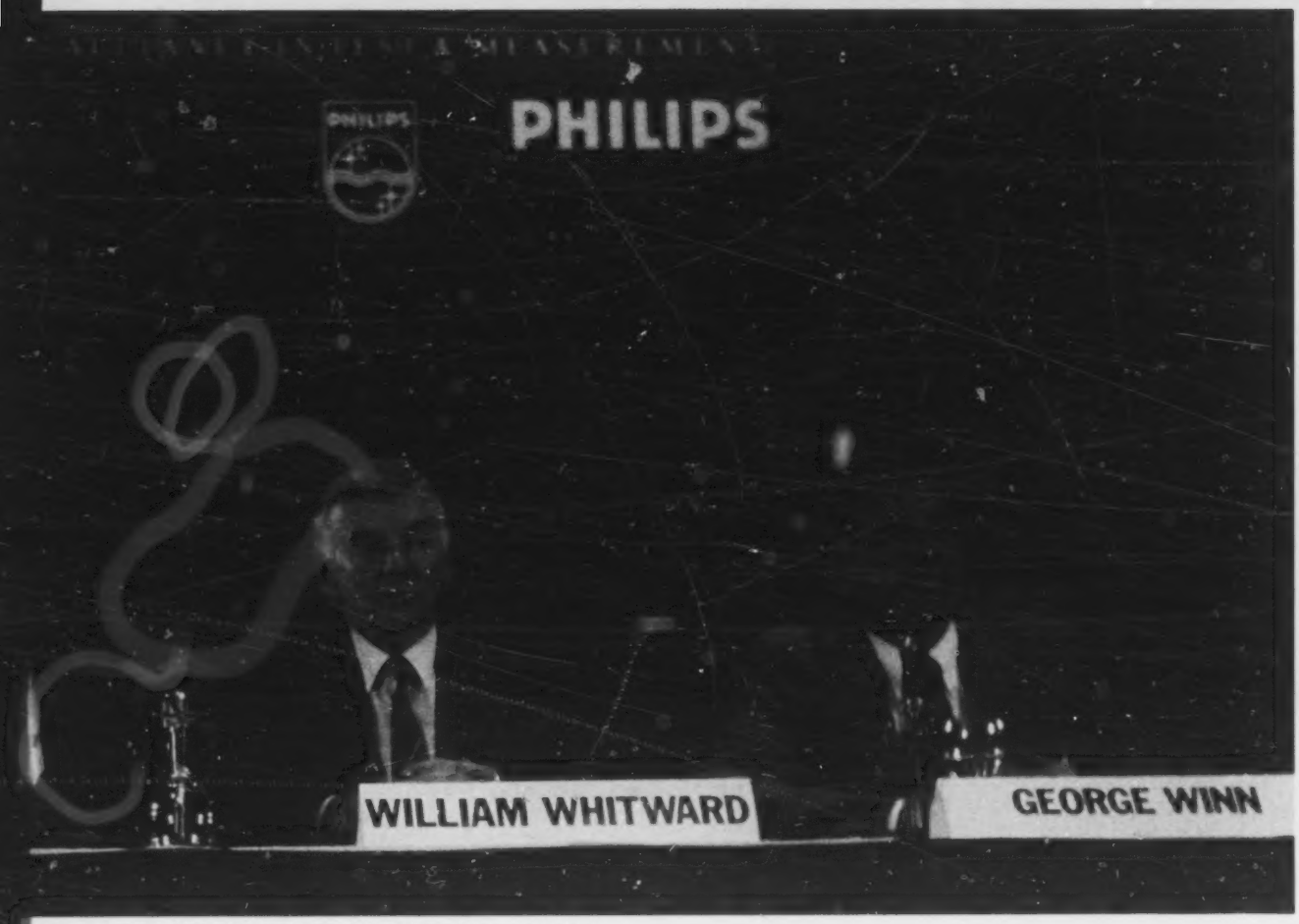
By David Card

Never before has the sleepy test instruments industry looked so international.

Consider the following hypothetical scenario: An American company with a Dutchman on its board, selling test instruments designed by Canadians but made in the Netherlands by a factory run by a South African, operating software from a company owned by a Swede.

The American company is the Everett, Washington-based John Fluke Manufacturing Company Inc. The Dutchman on its board is George de Kruiff, senior managing director of N.V. Philips' Industrial and Electroacoustic Systems Division. Last fall, the $27 billion Philips empire bought a $16.5 million piece of Fluke and a seat on its board of directors to seal a joint marketing and development deal. Joint manufacturing will probably follow.

Fluke, in turn, took a $6 million equity position in Hilevel Technology Inc., a small California tester company run by Sweden-born Bjorn Dahlberg. This month, Fluke is introducing a new model in its digital tester/troubleshooter line; the tech-



executive de Kruiff. Philips T&M chief Whitward has a say too

nology for which Fluke bought from Canadian start-up Innovage. Fluke also has an equity position and a seat on the board of Innovage, as well as an exclusive manufacturing license.

Something was needed to pep Fluke's performance and to give it more clout in the test and measurement arena. Although it is a leader in handheld instruments, Fluke, whose sales have hovered around $200 million for the last four years, looks puny compared even to No. 2 in worldwide T&M markets, Tektronix Inc., which celebrated its 40th birthday two years ago with $1.4 billion in sales. By contrast, Fluke's 40th fiscal year, which ended Sept. 28, 1987, showed $206.3 million in sales for after-tax profits of $2 million. Profits were hurt by the $7.5 million in restructuring costs which the company soaked up because of the Philips deal.

Observers believe they know why Fluke sought a major partner. " 'How far can you go as an independent company?' they asked themselves at Fluke," says Fluke watcher Jay Cooper, an analyst at investment brokerage Eberstadt & Fleming Inc. "Their conclusion was: no farther, without help." Cooper adds that a lot of Fluke's instrument business — laboratory multimeters, calibration equipment and even handheld meters — is in "quasi-mature" markets.

Fluke chairman John Fluke, Jr. admits that he would like to expand Fluke's reach. Under the Philips deal,

Analysts say that what the two companies do in the way of development is more important than what they do in marketing

the two companies will resell each other's instruments in assigned countries. "The product categories we're in today give us access to maybe a third or a little more of the total T&M market," he says. Market research firm Prime Data Inc. tabs the world T&M market at $7.2 billion in 1987, including $5.5 billion in instruments. "This Philips product line is pretty much in the other two-thirds," Fluke continues. "So obviously, the growth potential is very good. I have to concede that part of what's driving our interest is that we have enlarged our market. Substantially."

In its "overall strategy to be better marketed," Philips' alliance with Fluke makes for a "very clear No. 3" in instruments, according to Philips' de Kruiff. And that may be asking for trouble from the industry duopoly, Tektronix and Hewlett-Packard Co. While a pair of $200 million instrument companies, each with its own niche (Fluke in service test, Philips in Europe), doesn't attract undue attention, the combined $400 million venture, with a product line that overlaps completely, might even draw notice from market giant HP.

The instruments market has been cut up and dished out. Tektronix owns the $1 billion oscilloscope market and leads the $300 million logic analyzer segment as well, according to Prime Data. HP is first in just about every other segment. So much for the Fluke/Philips team? "It's a bigger deal for Fluke than it is for the industry because the industry is so oligopolized, with Hewlett and Tek so strong," says Eberstadt's Cooper.

Adds analyst Galen Wampler of Prime Data: "The people they will hurt the worst are the smaller people. HP and Tek will feel it, but not dramatically."

Competitors are at least more aware than they were. William Terry, executive vice president in charge of HP's Measurement Systems Sector, says that before the Philips/Fluke deal, he didn't even know who was in third place. "This probably does make them a clear No. 3," he says. Terry is intrigued by the deal; he says that he's never seen such a two-way reselling arrangement in the test industry. He thinks the two could be heavyweights in setting international standards.

"There's an advantage in having a reasonably broad product line," Terry continues. "If I take a current HP catalog and put a paperclip around the pages that Fluke competes with, it comes to, oh, 12 to 18 pages. If I clip Fluke and Philips together, it gives 80, maybe 100 pages. That's out of 800."

Second place Tektronix is similarly unfazed. Comments executive vice president Willem Velsink: "Philips in the past has not been extraordinarily successful in these types of deals." Velsink concedes that the product lines of the two are complementary, but he thinks their cultures may not be. "Philips is a marketing, authoritarian type of company," he says. "That'll go over like a lead pipe at Fluke."

John Fluke, Jr. has a quick reply to that: "There's no aspect of this agreement that requires any co-mingling of corporate cultures. We want to be us and they want to be them."

Fluke president and chief executive George Winn says that two years ago the company reorganized its salesforce along market and key account lines, away from its traditional product orientation. But to make that sa lesforce efficient, they needed to have a bigger "market basket" to offer the customer. "The age-old way to do that is to make a bunch of acquisitions," Winn says. "If you don't like to do that, you become a marketing company. You become a rep."

Philips and Fluke are doing joint market research and setting up a seed fund for potential start-ups

So Fluke became a rep. The company will sell and support Philips products — including oscilloscopes, logic analyzers and microprocessor development systems — in North America, Japan, Israel and China. Philips will return the favor elsewhere in the world.

Winn thinks the new product lineup will help level the proverbial playing field. "Hewlett-Packard has historically been a one-stop shopping center," he concedes. "We're not where Hewlett-Packard is, but we've made a lot of progress." All that efficiency of sales that Fluke hungers for, HP has in spades. An HP salesperson can walk up to a customer with the catalog that the industry refers to as the instrument wish list. On top of that, with the industry-standard General Purpose Interface Bus (GPIB) — previously the *HP*IB — and with HP computers, that salesperson can put together a rack of instrumentation and software geared to test automatically a given electronic component or subassembly.

"We're going to have to do a better job of how our system elements work together and how our software works in," Winn says.

Sealing the deal

"We probably talked to 10 different test and measurement and related companies in our search for a fit that would accomplish our objectives of expanding our solutions to the customer, creating an environment where we could get more sales efficiency and grow in a nongrowing test instrument environment," Winn says. To give the deal a little staying power, Philips acquired a preferred class of Fluke stock that, if converted, would total 7.5% ownership of Fluke. "We did not want in any relationship we got into, to have it just be some kind of marketing thing. The customer is pretty smart. He's seen an awful lot of marketing agreements come and go," Winn says realistically.

Philips director William Whitward, head of the Dutch giant's Test and Measurement business unit, echoes similar sentiments. "We wanted to show continuity in a marketplace where shakeouts are occurring regularly." Philips also looked around before signing on. Figuring that the United States was worth some 48% of the global instruments market narrowed the field. "To use a Japanese company to get into the U.S. market sounds a little paradoxical," says Whitward. The two biggest U.S. instrument companies, HP and Tek, were out of the question because of directly competitive product lines, he says. There is little or no overlap between Fluke's instruments and Philips'.

The deal goes beyond selling each other's lines. In fact, according to Prime Data's Wampler, what the two companies do in the way of development is more important than what they do in marketing. It is too early to predict what Fluke and Philips will come up with, Winn says, but staff from both companies are sniffing out

AT A GLANCE

John Fluke Mfg. Co. Inc.
Everett, Wash.

	FISCAL YEAR COMPARISON		
	1987	1986	Change
Sales ($ thousands)	$206,328	$209,030	-1.3%
Net income ($ thousands)	$2,005	$12,156	-83.5%
Net income/sales	1.0%	5.8%	—
Cost of sales/sales	46.7%	45.8%	—
R&D/sales	10.8%	11.5%	—
Marketing, G&A/sales	24.3%	22.3%	—
Capital expenditures/sales	4.0%	4.3%	—
Number of employees	2,400	2,500	-4.0%
Sales per employee	$85,970	$83,612	+2.8%
Net income per employee	$835	$4,862	-82.8%
Current ratio	2.23	4.42	—
Debt/equity ratio	0.01	0.13	—

Fiscal year ended September 25,

Source: Company reports, ELECTRONIC BUSINESS

possibilities. "Of course, Philips has a tremendous technology base," Winn understates. "They've got 4,500 research engineers." Fluke is particularly interested in Philips' video expertise from its television products, its digital/analog conversion technology and its ability to squeeze multiple functions into a single integrated circuit.

The two are doing market research and setting up a seed fund for potential start-ups, Winn says. He won't say how much money is involved. The joint venture could go a number of ways: "We could go outside and buy somebody. We could go outside and appoint a president and have him start hiring engineers and start something from scratch. We can make some complement of Fluke people and/or Philips people," Winn says.

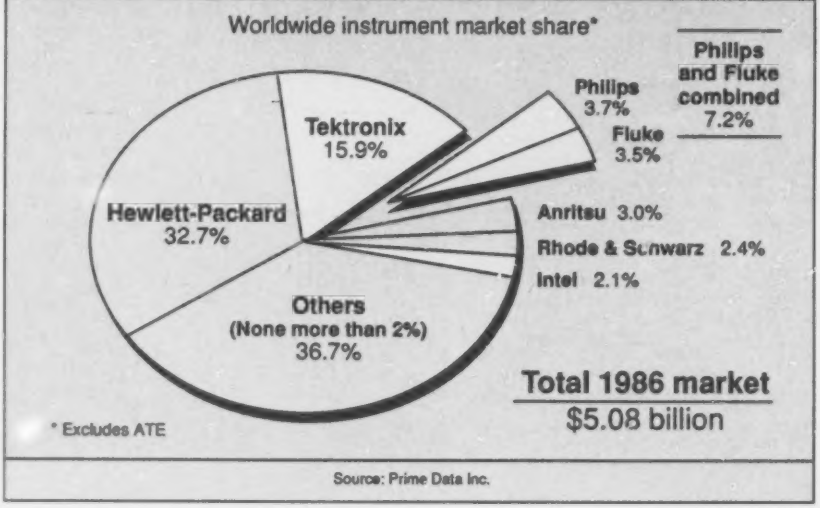
Single-site manufacturing

John Fluke, Jr. is operating under a long shadow. His father, John Fluke, Sr., is an industry legend, a garage-shop founder. At Fluke headquarters in Everett, next door to Boeing Co.'s jumbo-jet plant, there is a memorial display for John, Sr. that is uncannily like a shrine.

One of the legacies the elder Fluke handed down was a fierce pride in his company's manufacturing expertise. But the company may have to swallow a little of that pride. John Fluke, Jr. is quick to praise his factory team that "makes it so that we can continue to build handheld meters right here in little old Everett, and compete successfully with the Japanese and the Koreans and the Taiwanese not only here in the United States, but compete with them successfully on their own darn soil." Indeed, observers credit Fluke with about half of the world market in handheld meters.

Fluke manufactures the whole thing, too. Holding up a benchtop instrument, a Fluke manufacturing manager boasts that his company makes everything from the resistor networks to the plastic casing. "We make everything in this except the plastic feet on the case," he says. "Well, maybe I'm wrong. I think we do make the feet." But the amount of automation necessary to build instruments, Winn says, makes the potential double efforts of Fluke and Philips inefficient. "So we're probably going to evolve into single-site manufacturing for the majority of the instrumentation of the future," he says.

Fluke/Philips makes for a strong No. 3, but is it strong enough to crack HP and Tek?



Source: Prime Data Inc.

Winn doesn't see much chance of Fluke taking over the manufacture of Philips instruments. Still, John Fluke, Jr. does point out that the bids on government instrument contracts — 13% of Fluke's business is with the government — are so close to manufacturing costs that some Philips products may migrate to Everett. A big Air Force oscilloscope contract has Philips salivating, says Prime Data's Wampler.

On the other side of the Atlantic, Fluke has a plant in Tilburg, Holland,

This opportunity to jump-start Philips' U.S. business does not come for free; Fluke is handing over its European business to Philips

that was conspicuously not included in the deal. Historically, Tilburg builds 35% to 40% of what Fluke sells in Europe, Winn says. "The amount of new product we're putting in there is not satisfactory to keep that factory growing," he admits. Philips could easily pick up the manufacturing done in Tilburg.

Besides new competitors, Fluke is faced with new customers. The bulk of the new-to-Fluke instruments — analyzers, signal sources, scopes and microprocessor development systems — are bought by design and manufacturing departments. How much experience does Fluke have selling into those areas? "Not a hell of a lot," says analyst Gerald Fleming of brokerage Bear, Stearns & Co. "The troubleshooter product has been successful going into manufacturing, but historically they've always sold into the service sector."

Potential risk

"You've hit on an area of potential risk," admits John Fluke, Jr. "We do have to develop a lot of new relationships with the design-engineering function of the companies we call on. The good news is that we've been calling on those companies for years. The calibration lab manager who has to maintain all that stuff knows us and thinks we're good.... We've got to convince them that we can supply them just as well as we supply their associates in the manufacturing, test engineering and field service engineering sections of their company."

Of course, this is not the first time Philips has tried to sell instruments in the United States. Philips has been trying for years. Eberstadt's Cooper says the Dutch company's sales never topped $15 million or $20 million stateside. Fleming of Bear, Stearns is blunt: "Philips had a horrendous record in the United States, with minimal success pentrating the market."

Philips' instruments chief Whitward admits that his company's previous attempts to gain U.S. ground "did not meet the targets we wanted," but blames it on the fact that Philips "hadn't found a good partner." He ranks Fluke's top two contributions as salesforce and name recognition, respectively.

Lisa Henderson, an international buyer for Siemens Corporate Research and Support Inc. in Iselin, N.J., says she has "very cordial rela-

tions" with Fluke and buys calibrators and interface boards from them. Her division helps buy for Siemens locations around the world. But she says she has never bought Philips logic analyzers, for example, going with models from HP or Tek instead. "I can get much better competitive prices with U.S. vendors," she says.

The weak dollar is helping ensure that Philips products are costly for U.S. buyers. But pricing surely is not the only issue. Was it the equipment itself? A year and a half ago, Fluke, as a precondition of the joint deal, took apart and thoroughly evaluated copies of the 20 major Philips products that Fluke expects to push most heavily. "We wanted to assure ourselves that Philips wasn't having trouble in the U.S. because of shoddy product quality, or excessively high component counts because they hadn't used the latest technology, or lousy manufacturing methods or whatever. And what we discovered is that many of these products are really impressive," says John Fluke, Jr.

So if the Philips instruments stacked up for technology, what was the problem? Dennis Pinnecker, an operations manager for Rockwell International Corp.'s Autonetics division in Anaheim, Calif., thinks he knows. Pinnecker has bought plenty of Fluke instruments among the 60,000 or so items of test equipment that Rockwell Autonetics uses in making guidance systems for nuclear missiles and submarines. "The instruments looked good, their maintainability looked good, but the main bugaboo was support," Pinnecker says.

He cites the long support chain, the warranty and a lack of staff on Philips' part as three strikes against the big Dutch company. Now that Fluke is in the picture, he is willing to take another look.

Fluke's fix for Philips

Meanwhile, John Fluke, Jr. has plenty of explanations for why the things that hurt Philips before, are all fixable by Fluke:

- "Now, we know from our surveys here in the United States that for some reason [Philips] has gotten a less than ideal reputation for field service. But we also know we can fix that.
- "Quite frankly, the people running the T&M portion of the Philips national sales organization probably found it difficult to get the level of resources they needed, and understandably so.
- "The number of layers between the people who run our data-processing organization, between those guys and the feet-on-the-street sales guys, you can count on one hand.
- "In the Philips organization . . . if a salesman wanted to pull up on the tube some information about customers, first of all, they didn't even have good computerized systems. Secondly, if he wanted that, he would have to go up through 20 layers of management, through international to home headquarters corporate interfaces, to some guy way up in the corporate castle to get a modification on a particular data-processing program. Here, our data-processing guy is requested occasionally to go and talk to the sales management in the field.
- "There's no one thing you can put your finger on. It's maybe the extent to which senior management of each

Fluke fallout in France

Not surprisingly, European distributors of Fluke's products are far from delighted with the Fluke/Philips alliance. In Britain, Germany, the Netherlands, Belgium and Luxembourg, Fluke has conducted its own selling. But in France, a major market, Fluke's products represent 30% of the distribution business of M.B. Electronique, based near Paris.

"It's certainly not good news for us," says Michel Brunswick, M.B.'s president. "However, Fluke has behaved correctly in giving us fair notice. Before the present contract runs out at the end of 1988, we shall have time to find new brands to sell. But we would need eight newcomers in our catalog to replace as big a name as Fluke."

JACK GEE

The Hilevel deal: Getting closer to CAE

Another deal may be getting ignored amid the Philips/Fluke hoopla — a deal that "could potentially be an excellent addition" for Fluke, according to Bear, Stearns analyst Gerald Fleming. That's the $6 million deal that John Fluke Manufacturing Company Inc. cut for 25% ownership of Hilevel Technology Inc.

Hilevel, of Irvine, Calif., makes a new breed of automatic test equipment to "verify" ASIC chips. In price and function, verification systems fit in the instrumentation spectrum between logic analyzers and million-dollar ATE systems. Typically, design engineers, rather than test engineers, buy the verifiers, which sell for anywhere between $50,000 and $250,000. The nascent market has spawned a handful of start-ups and drawn serious attention from the big T&M companies.

"Fluke was very interested in participating, not in ASIC design verification or ASIC component test — Hilevel's business — but in having the know-how to do digital board test for boards that contain ASICs," says Fluke chief executive George Winn. So Fluke took an option in Hilevel, which was looking for money at the time, and got access to Hilevel software and pin electronics.

Hilevel makes ATE equipment to "verify" ASIC chips

Hilevel president Bjorn Dahlberg — who claims his company had $12 million in sales last year and was "very profitable" — says he thinks Fluke wants to leave his company independent. Joint marketing does not make much sense yet, Dahlberg says. "Our strength is in engineering labs and my guess would be that Fluke is strongest in manufacturing."

Analyst Galen Wampler of market research firm Prime Data Inc. likes the deal. "They [Fluke] have to get closer to computer-aided engineering, and Hilevel helps," he says. Hilevel's software translates data generated by CAE simulators into a form that can be used by Fluke's functional board tester, which sits at the low end of the ATE market. □

of the two organizations would pay attention to people. I go on sales calls all the time with salesmen . . . I don't think the head guy at Philips ever made a sales call with any of the salespeople. That's not a criticism of them — how could he possibly do it?"

John Fluke, Jr. makes a good case. A consensus of his customers, competitors and investment analysts shows that Fluke has a solid service and support organization. Competitors give its computerized sales-support system rave reviews.

Of course, this opportunity to jump-start Philips' U.S. business does not come for free. Besides the restructuring costs, which forced Fluke to take a loss for the fourth quarter, Fluke is handing over its European business to Philips.

Twenty-two percent of Fluke's sales were in Europe last year, and it was a profitable business. John Fluke, Jr. reasons that if around a quarter of the world's instrument business is in Europe, Fluke was doing pretty well. To do better would have called for heavy expansion, he says. Fluke had wholly owned subsidiaries in England, West Germany, Belgium and the Netherlands. Contracts with reps elsewhere in Europe are being allowed to run out.

John Fluke, Jr. says the company "agonized" over the decision to dismantle its organization over there. "But the problem is," he says, "particularly in the military and aerospace markets in Western Europe, if you're not a European company, you're going to have an awful hard time getting your fair share."

Fluke admits that the five-year marketing agreement could be dissolved, at which time Philips could begin acquiring Fluke common stock

What's going to suffer is Fluke's profit margin. Winn says that typically, a rep gets a 12% commission, while distributors that stock equipment "operate in instrumentation, someplace between 20% and 30%." He adds: "Our decreased margin from products in Europe is going to be about balanced by decreased cost."

"The last issue is," according to Fleming of Bear, Stearns, "is this ultimately the first step toward a marriage? I don't know. There appears to be a desire on the part of John, Jr. to move away from the business. I think Philips has a high level of interest in acquiring U.S. properties."

Eberstadt's Cooper sees logic in that. "American companies are on the bargain counter now. I would bring the dollar-versus-guilder argument right up front. Philips is no different than the Japanese companies to an important degree — they have to get into the low-currency countries."

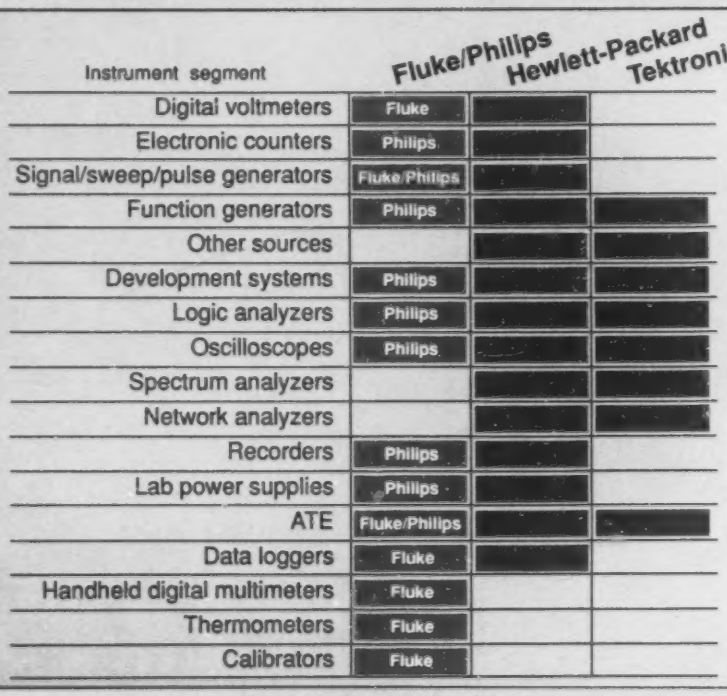
John Fluke, Jr. himself denies that he's pulling out of the business, though he just recently turned over the chief executive title to Winn. When asked if a marriage is indeed in the works, he only half-jokes: "I think Philips is pretty sure we're not going to buy them. They're a hundred times our size." More seriously, he admits that Philips could easily swallow Fluke. "But the fact is that, in our lengthy and detailed negotiations, it was apparent that they [Philips] really had no particular intent of attempting to buy this company."

An "airtight" standstill agreement ensures independence, John Fluke, Jr. says. But airtight is a relative term, it turns out. When pressed, he admits that the five-year marketing arrangement could be dissolved, at which time Philips could begin acquiring Fluke common stock.

Speculation aside, John Fluke, Jr. says he wants to be sure that the deal doesn't get overplayed. "The performance of the core company, the company less Philips, is as critical as it ever was," he says. "Bear in mind that the Philips products come in here at some transfer price. That cost of goods is definitely higher than the cost of goods sold for Fluke products. We cannot afford to have our field salesforce out there meeting its dollar-volume quotas, but doing it by selling relatively more of the Philips product line than was forecast and relatively less of the core company's. That is an intolerable outcome."

John Fluke, Jr.'s hope is that the companies' extended product line, plus Fluke's service and support, will prove an irresistible combination. If it is enough to make a potential customer call "this vendor called Fluke with the Philips flag over the top" before calling his competitors, that in the end is all that Fluke wants. □

Fluke/Philips' expanded product line goes head-to-head with HP's and exceeds Tek's



Source: Company reports, Prime Data Inc.

Computer Business

EUROPEAN PCs

The rise of the European PCs
Europe lags the U.S. in many market segments. PCs are no exception.

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MINISUPER-COMPUTERS

Minisupers: Prices cut; competition's up
The maturing minisuper market is crowded and suffering from price declines. A shakeout's coming.

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INFORMATION SERVICES

Baby Bells entering a risky business
The seven RBOCs are going after the videotex services market. BellSouth leads the way.

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COMPUTER FOCUS

DEPARTMENTAL COMPUTERS

DEC could surpass IBM in midrange market share

IBM's tenuous lead in the departmental computer market may vanish this year if the balance tips in DEC's favor

The departmental computer market is known as Digital Equipment Corp.'s bread and butter. It is also known as the bane of IBM's existence. DEC is known for its strengths while Big Blue is recognized for its weaknesses. Despite that fact, IBM has always held the lead share of that market. According to a survey of 1,045 companies conducted by The Sierra Group, last year IBM accounted for 18.6% of the departmental computer market while DEC held second place with 13.6%.

That may change this year. For the first time since the inception of the departmental computer market, IBM may lose its first place status.

The Tempe, Ariz., market research firm survey included companies from eight major vertical markets with revenue ranging from $10 million to $3 billion. Of those surveyed, over half said they would purchase more departmental systems this year. Of the DEC users, nearly 60% were planning to buy computers, while about 51% of the companies with departmental systems installed had minicomputers from more than one vendor. Less than 1% reported having machines from more than two vendors.

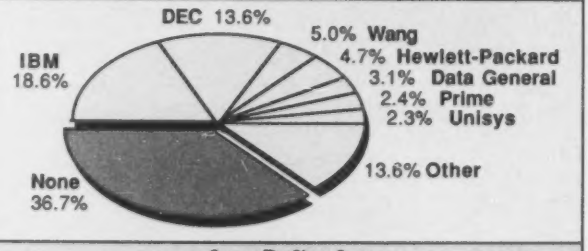
Of the companies surveyed, 36.7% did not have departmental systems installed. Of those, 21.7% said they would install departmental machines within the next 12 months.

About 37% of those companies with IBM mainframes did not have departmental machines. But nearly 27% of those customers plan to purchase minicomputers in the next 12 months.

That does not necessarily guarantee sales for Big Blue, however. DEC sold almost 15% of the departmental systems used in IBM mainframe accounts, second only to IBM's 30.9% share of that segment of the departmental computer market.

The most active customers, says the study, will be scientific and engineering users. About 51% of the respondents from that vertical market plan to increase expenditures on departmental systems this year.

Departmental computer market



Source: The Sierra Group

PERSONAL COMPUTERS

The rise of the European PC industry

Europe lags the U.S. in many market segments. PCs are no exception. Look for strong growth this year

By Jack Gee

It took Europe three years to catch up with the United States in rolling out the red carpet for the personal computer. But since 1984, when the first pioneer machines were installed on desktops in Britain, France, Germany and neighboring countries, diffidence has given way to enthusiasm.

The advent of a younger generation of more powerful and versatile models from both European and U.S. manufacturers is being celebrated with applause — and bulging order books. And, like 70% of the 2.7 million PCs shipped in Europe last year, most of these new purchases will be produced at European plants.

"There's a big potential for Europe's PC business," says Brigitte Morel, cofounder and joint managing director of Intelligent Electronics Europe, a microcomputer market study firm based in Paris. "Volume growth might drop from over 30% in 1987 to around 20% this year. That could be one of the effects of the world financial crisis. But, in any other industry, a comparable rate of development would be regarded as amazing."

However, Hans-Dieter Wendorff, senior vice president, products, at West Germany's Nixdorf Computer AG, comments: "We see no slowdown in PC sales in the European market. Indications are that the market will continue to grow. In the past, business cycles outside our industry have not affected the computer business."

At Italy's Ing. C. Olivetti & Company SpA, chairman Carlo de Benedetti expresses confidence. "We shall weather the storm," says the veteran European industrialist and financier. "When I first went into business, my grandfather taught me that the first lesson is not to have debt. Olivetti does not have debt."

Benedetti, whose company is based in Ivrea in the foothills of the Italian Alps, expects profits for fiscal 1987, ended in December, to drop. Revenue has been hurt because AT&T, which has a 23.5% stake in Olivetti, bought only one-third of its output of PCs during the year. This was a hard blow because Olivetti depends on PC sales for one-quarter of its revenue. But Benedetti says that this year, AT&T will double its PC purchases to 120,000.

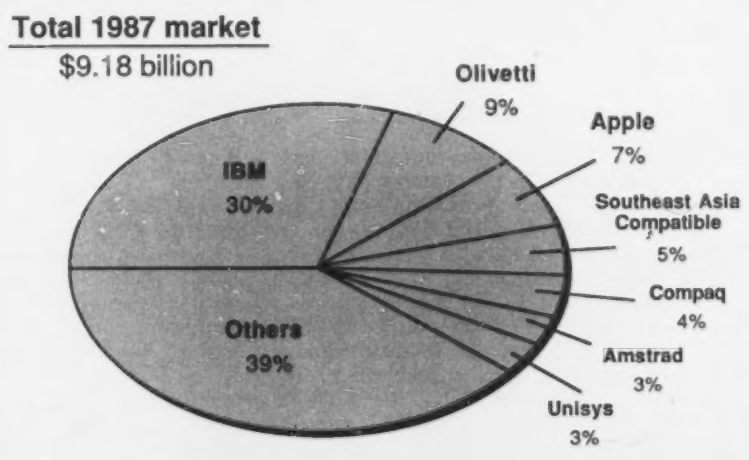
Olivetti's performance was also undermined by the mammoth task of restructuring Triumph Adler, a German typewriter and PC acquisition, and by completely revamping its own PC line to meet the market conditions created by IBM's introduction of the Personal System/2 range.

Space awaits

In Europe, plenty of space on European desks awaits PCs because they have so far found their way to only 12% of them. That compares with

European PC makers are gaining market share at home

Estimated European personal computer market shares



Source: Intelligent Electronics Europe, Dataquest

Growth worth celebrating: European microcomputer revenue rose 36% in 1987

over 18% in the United States. However, Intelligent Electronics, which was acquired last year by market research firm Dataquest Inc., expects the speed at which local white-collar workers move from pen and paper to PCs will vary. Within two years, 30% of Swiss office personnel are likely to have their own machines, but only 20% will have them in Italy.

Buyers are taking a hard look at the PC strategies that will best help their own businesses prosper over the next five years. For many the choice is confusing. Lower prices for PCs of the previous generation are opening up new desk space. Simultaneously, higher performance machines are pushing their way into the lower end of what, until recently, was regarded as the preserve of the mini-and mainframe computers.

Intelligent Electronics' Morel comments: "The past months have been marked by the emergence of a more diversified marketplace for PCs in Europe. It is no longer a single product market." Large account users are going after development of productivity and full-scale networks which draw on all the resources of PC technology. Desktop publishing is now an area in which the PC is pushing strongly."

Students, executives and small-business people who work at home have opened a new PC market in Europe. This home market accounted for only 10% of European microcomputer sales in 1986. Last year it represented 30%. Many purchasers have chosen the $700 IBM-clone designed by Amstrad Consumer Electronics Plc, a British manufacturer (see related story) which in earlier years made its mark with high-fidelity units and a simple but successful word processor. Last year, Amstrad sold 300,000 MS/DOS PCs in Europe and became the continent's No. 2 supplier by units. However, in revenue terms it was way behind the leader, IBM, which sold 600,000 units, Olivetti and Apple Computer Inc.

"We are not just catering for the ongoing requirement," says Keith Warburton, Amstrad's manager of business products. "Our pricing has uncovered an unsatisfied need. We are pulling from the future the customers who might have gotten around to buying a system eventually. But they would have needed time to put the finance and budget justification together. We are making that product available now."

In U.S. dollars, European microcomputer revenue is rising at a spectacular rate. It grew by 43% in 1986 and by 36% in 1987, according to Intelligent Electronics. Reckoned in European currencies, which are a better yardstick because these are not distorted by the plunge of the dollar's exchange value, sales rose by 20% over each of the past two years.

This year is a major landmark for the PC because most models will be celebrating their fifth anniversary in Europe. For many of them, 1988 will mark the end of their lifespans as faster, more powerful machines that use Intel's 32-bit 80386 microprocessor edge their elders out. Compaq Computer Corp.'s Deskpro, which incorporates this chip, is faring well on the European market. Users are also waiting impatiently for delivery of many models of the IBM PS/2 machines. At present, they must wait for as long as six months. Compaq has recentlyjoined IBM in producing micros at its own plant in Scotland. ▷

Hal Mayforth

At his headquarters in Munich, West Germany, Eckhard Pfeiffer, senior vice president, international operations, for Compaq, is naturally worried about the threat from the PS/2. "IBM has muddied the waters," he says. But Pfeiffer adds: "The market is not about to rush off in a new direction just because one large company changes the signposts around. You can't turn an oil tanker on a sixpence. Big businesses are not turned easily, either. Compaq has demonstrated that the highest performance in PCs is available within the old standard."

However, Intelligent Electronics' Morel says: "The advent of PS/2 has brought dramatic change. IBM has signaled that it is challenging the MS/DOS operating system that it first set as an industry standard. It is doing this with its Micro Channel [a proprietary bus for plugging in circuit cards for communications], extra memory and other functions. From now on, we could be facing several manufacturing standards for PCs."

Among European manufacturers, Italy's Olivetti and West Germany's Nixdorf Computer AG have joined IBM and Compaq in introducing new families of computers over the past few months. "Everybody is trying to get onto the starting blocks of the new era," says Morel. "They all want to cater for European users who are shopping for more technology at the old price with greater use of graphics, multitasking, sophisticated communications and 101-key keyboards."

As the European PC market matures, the selling scenario is changing. Nixdorf, which until now has stood aloof from the scramble and concentrated on its minicomputer customers, is going into the large account market as a contract PC supplier. "We've already got batch orders for

The home computer market, which accounted for only 10% of total European sales, may be ready to break wide open

thousands of machines from Fiat and Allianz, Germany's biggest insurance firm," says Wendorff, the manufacturer's products chief.

Adopting a similar strategy to Compaq in promoting its new range of 80386-based PCs, Nixdorf is preparing to present a competitor for the PS/2 at Europe's CeBIT microcomputer show in Hannover, West Germany, in March. "We shall go into this new arena with OS/2 kits that we intend to run on our own machines. Depending on how fast Microsoft delivers the software, we plan to begin shipments in the second quarter of 1988," adds Wendorff.

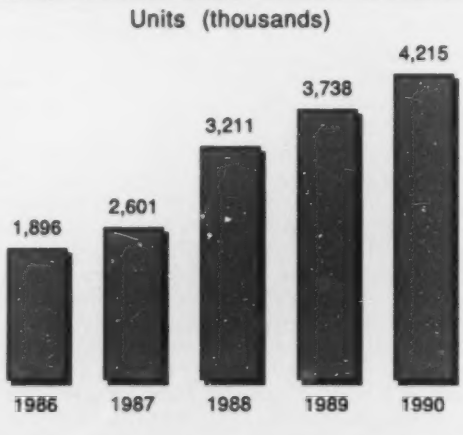
Nixdorf has made its mark in Europe by selling banking and retail business systems. It has scored a similar success in the United States with a $100 million deal with Montgomery Ward. Heinz Nixdorf, the West German manufacturer's founder, long believed he could capture sales by providing the company's own proprietary hardware and tailored software solutions. Klaus Luft, his successor as chairman, has now recognized that its products must be compatible with those of IBM if Nixdorf is to make an impact in office and factory automation.

Wendorff says: "Even though we are now introducing a full range of PCs, including an OS/2 compatible model, our PC business is still relatively small. But it is now a strategic axis of our development and, in the medium term, could grow to 15% of our business."

Lines are drawn

Olivetti is founding its strategy for recovery on a new line of both micros and minicomputers of its own design. Alberto Alonzo, an analyst with Barclays de Zoete Wedd, says: "They are trying to promote a new Olivetti look. This is a culmination of Olivetti's strategy of being not just a

European PC shipments grow both in units . . .



Source: Intelligent Electronics Europe, Dataquest

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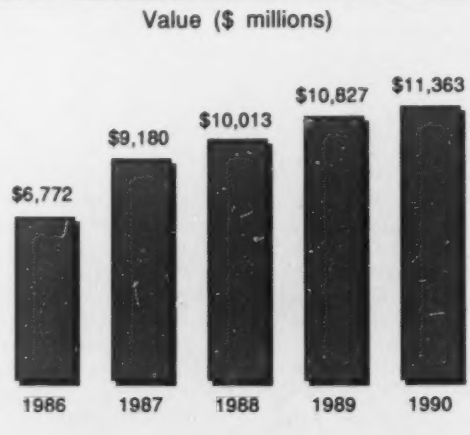

Source: Intelligent Electronics Europe, Dataquest

maker of computers, but offering networks and services."

Olivetti's expansion plans and government investment in electronics should take Italy's semiconductor market to $700 million in 1988. However, semiconductor industry specialists do not regard the PC industry as the fastest growing segment of their business. Jan Calen, marketing director for Europe at Motorola Semiconductors, says: "Telecommunications will give a bigger boost than computers to European chip sales, which we expect to grow by 8.3% in 1988."

In Europe's maturing PC market, there are increasing signs of specialization by manufacturers and dealers. In the highly competitive large account business, Unisys has arrived with PCs to complement the minicomputer systems traditionally offered by its founders. Siemens AG of West Germany; France's Groupe Bull; and the United States' NCR Corp. are also strong contenders. IBM has reaffirmed its claims with the announcement of the PS/2.

National manufacturers such as Bull, Siemens and Britain's Apricot and the Netherlands' Tulip are strongly positioned among value-added resellers in their local markets.

The development of Europe's PC market will depend on how the business user community reacts to the recent turbulence in the financial world. Intelligent Electronics' Morel comments: "The crisis could discourage capital investment in PCs by large account users. The upheaval in the big money centers is also seriously affecting the financial position of components manufacturers in southeast Asia. The fortunes of these suppliers are closely tied to the stock exchanges in Hong Kong and Taipei. Although the PC market will continue to grow, the immediate outlook is far from stable."

JACK GEE

Amstrad's Alan Sugar: Wonder boy of the European PC business

Alan Sugar began his business career hawking car-radio antennae from a van in London's East End. Today, as chairman of Amstrad Consumer Electronics Plc, he is said to be worth $700 million. Sugar owes his fortune to a 45% stake in this company which, starting out as a small peddler of high-fidelity systems, now sells more microcomputers of all types in Europe than IBM.

Sugar makes no bones about his ambition. "At Amstrad, we want your money," he proclaims. Vaunting the merits of mass-merchandising PCs, he says: "Our marketing philosophy is: pile 'em high, and sell 'em cheap."

This approach has worked well in Britain, where Amstrad word processors and, more recently, personal computers have saturated the national market. The Amstrad PCs are also selling well in other parts of Western Europe. Based on Intel Corp.'s 8086 microprocessor, the Amstrad PC 1512 has a memory capacity of 512K RAM.

But, since Sugar introduced his IBM clone in September 1986, his market forecasts have been dampened. Although he announced sales would start at 70,000 a month and rise to 100,000, they are averaging only 30,000. Priced as low as $700, the Amstrad PCs sell briskly through mass merchandisers. But they have poor acceptance among large corporations.

This corporate diffidence is affecting the company's growth. Amstrad, which has reported triple digit annual growth rates since 1984, reported only a 35% rise in pretax profits for the first six months of 1987.

Performance in the United States has also been disappointing. Amstrad made a sluggish start two years ago. Until last fall its machines were marketed by Sears World Trade Inc., which Sugar accuses of failing to use his aggressive sales tactics. Now he has acquired Vidco, a Texas-based distributor, for $7.5 million and hopes to increase the U.S. contribution to Amstrad's revenue from 8% to 30%.

"By 1990, the U.S. could be our leading market," Amstrad's founder proclaims. But perhaps the wonder boy of corporate Britain might have to review his American objectives once again. □

APRIL IN

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INFORMATION SERVICES

BellSouth: Risky business for the biggest Baby Bell

Banned from manufacturing, the seven RBOCs are going after the videotex services market. BellSouth leads the way

Since the breakup of AT&T in 1984, Atlanta-based BellSouth Corp., with 15 million customers in nine southeastern states, has emerged as the largest of the resulting seven Regional Bell Operating Companies (RBOCs). For all its girth, however, the biggest Bell on the block could hardly be called the biggest risk taker, especially in the datacommunications business.

It wasn't BellSouth, for example, that bought IBM's Atlanta-headquarted chain of computer retail stores two years ago, but Nynex Corp. of New York. To be sure, BellSouth's conservative strategy has avoided some problems faced by other RBOCs.

On the other hand, BellSouth hasn't blazed many new trails. As Lap Lee, an analyst for Salomon Brothers Inc. in New York City, put it: "BellSouth has a good batting average but doesn't hit many home runs."

That cautious image may be changing. BellSouth's two telephone operating companies, Southern Bell and South Central Bell, have invested heavily in fiber optics for improved data transmission. And BellSouth is now pioneering a risky business whose regulatory boundaries are still being drawn — information services.

The only game in town

In the current legal environment, industry experts say information services promises to be the only new multibillion dollar business open to the RBOCs in the next five years. U.S. District Judge Harold Greene, who monitors the RBOCs compliance with antimonopoly regulations, has denied the Bells permission to manufacture equipment or offer interexchange long-distance service. But in recent rulings, Greene has given his conditional OK for entry into information services.

As a model, Greene cited the Minitel system in France. There, some 3.3 million business and residential consumers use Minitel terminals — small, nine-pound terminals that plug directly into phone outlets — to order goods, pay bills, and subscribe to news and entertainment services supplied by 3,500 independent service providers.

The RBOCs, according to Bernell Wright, a consultant with Link Resources, a subsidiary of International Data Corp., in New York City, will participate in a segment of the information services market known as videotex services — defined as electronic services, such as database access and voice messaging, offered over public telephone networks. Last year, that portion was a $120 million market, says Wright. With the entry of the Bell companies, Wright predicts the market will more than double, reaching $384 million in 1990.

For all its potential, however, videotex services has been an industry rife with failures. In the past two years, Knight-Ridder Inc. and Times-Mirror Co. each abandoned such services after investing tens of millions of dollars, concluding the ventures were ahead of their time.

Videotex market will double by 1990 if RBOCs enter the market

Source: Link/IDC

BELLSOUTH's BOREN: "One of the things this industry has suffered from is overhype"

But the time may be right for the Baby Bells, says BellSouth vice president Sidney Boren. He believes that the RBOCs, with their ubiquitous networks and unrivaled penetration into home and office markets, could make videotex services available to a wider audience. Through economies of scale the services could become more affordable. And if dialing a database was as simple as dialing a telephone, and billing and menus came from a single, familiar source, more customers might use the services, he says.

"The key is going to be education and marketing," says Boren. "The great majority of people are not comfortable with computers. We have to show people what is available and how to use it."

BellSouth plans to play

So far, BellSouth has been leading the way. "BellSouth is first right now in gateways and infrastructure," says Joshua Harris, a researcher for Jupiter Communications Inc. of New York City, which prepared a fall 1987 report on the RBOCs' preparedness to enter the videotex services business. By 1990, the report predicts, San Francisco-based Pacific Telesis and BellSouth will be the first to achieve "critical mass" in the consumer market for videotex services.

The company has pushed ahead of its siblings with several industry-leading moves in the past six months. BellSouth became the first RBOC to demonstrate a functional "gateway"

for videotex services at an industry show in Chicago. The gateway would be the part of the telephone network that customers dial up to see a menu of available services.

The company also signed a first-of-its-kind deal with Telenet, the data-communications arm of US Sprint. The agreement allows customers outside of large cities to gain access to Telenet's services without paying for a toll call.

And BellSouth announced a deal with National Data Corp. of Atlanta, the market leader in providing transaction services for bank credit cards, to put special terminals in 10,000 pharmacies in the Southeast. The terminals, made by a yet-to-be-named third party manufacturer and resold by BellSouth, will route insurance and payment videotex to National Data's mainframes.

Providing videotex services could create demand for mass-market terminals that Bell companies could resell. Boren says BellSouth is now exploring its options but has yet to sign a deal with a terminal maker. Among other manufacturers, BellSouth has had discussions with U.S. Videotel Inc. of Houston, which has U.S. marketing rights for the Minitel terminals made by an arm of French manufacturer Alcatel.

Boren declines to say if terminals supplied by Videotel, or other manufacturers such as Hewlett-Packard Co., would be part of videotex services field trials which BellSouth says it will be ready to conduct within six months.

But Boren says the videotex services network should not be limited to "dumb" terminals, such as the Minitel system in France. In the United States, says Boren, "there are 25 million PCs and other smart terminals out there, and we would be foolish to ignore that."

Despite that, however, less than 1 million people currently subscribe to videotex services. The largest service provider, CompuServe Inc. of Columbus, Ohio, has about 370,000 subscribers.

Boren is aware of BellSouth's uphill battle. He cautions that videotex services is not likely to be an overnight revolution. "One of the things this industry has suffered from is overhype," he says. "We kept hearing about the checkless society, and it never happened. We've got to be realistic about the acceptance of the public. It will be a very gradual process."

CHARLES ELMORE

Do yourself a service Let ELECTRONIC BUSINESS readers know about your services

Next August 15, ELECTRONIC BUSINESS will publish its annual directory of Services for the Electronics Industry. If your company can help other electronics and computer companies complete a project on time, save costs, reduce risk, get to market faster and safer, increase efficiency, improve quality, or any other pertinent electronics service, the name of your company or division, and the type of service it provides for our readers, belong in the pages of the ELECTRONIC BUSINESS directory.

Example of services that will be listed:

Design: product design, circuit design, custom ICs, design centers, software development, package and packaging design, thermal design, documentation.

Manufacturing: contract manufacturing, printed circuit design and fabrication, mass lamination, purchasing services, kitting services, value added services, cabling, connector assembly, quality assurance service, just-in-time services, component procurement services, production software services, electrostatic discharge protection services.

Test: electrical test services, environmental testing, failure analysis, instrument rental services, test software development, production testing.

IC Foundry: silicon, CMOS, custom processes, gallium arsenide.

IC Assembly: die attachment, wirebonding, packaging, marking, sorting.

Distribution: services by and for industrial distributors, distribution channels, dealers, packaging for distribution and retailing, point of sale services.

Training: quality training, statistical production control, JIT training, purchasing, negotiating, management training.

Management: product strategy, global strategy, international operations, management consulting, temporary additions to management team.

Marketing and Sales: strategy, market research, product strategy, product position, sales representation, product promotion, export promotion, advertising, public relations.

Financial: leasing, banking, insurance, venture capital, mergers and acquisitions.

Transportation: freight forwarding, air cargo, customized packaging.

How to submit your listing:

- Name, address and telephone number of company or division that performs the service. If available, add telex and fax numbers.
- Type of service: Please be specific. (If you enter in more than one category, such as design and manufacturing, please list separately.)
- Name of managers(s) responsible for services for electronics and computer companies. Include direct telephone number, if available.
- Current volume of sales of this type of service to electronics and computer companies.
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Electronic Business

PRINTERS

Europe's printer wars: Losing the battle to Japan

Japan's printer makers are planning to build Euro-factories to beat the tariffs their European rivals are howling for

Europe is flexing its muscles for a battle royal with Japan. Unlike the U.S. electronics industry, the Europeans are not pulling on the gloves for a fight over semiconductors. Their bone of contention is Japan's pricing policy for printers. With sales of 2 million units a year, these have captured 30% of the Europeans' home market. For its counter-attack, Europe has devised a strategy which, before this spring, could produce tariff duties on imported Japanese machines.

Seven of Europe's largest printer makers, including NV Philips and Mannesmann Tally, have joined forces under the banner of the Europrint Association, to defend their interests. They have persuaded the watchdog commission of the 12-nation European Common Market to undertake an anti-dumping investigation covering a score of Japanese manufacturers of matrix and daisy wheel printers.

While the debate heats up over Japan's place in the European printer business, the market is booming. Between 1985 and 1986, sales more than doubled, from $350 million to $750 million, and since 1981, the electrophotographic page market has expanded eightfold. Market watchers expect this technology to be the strongest long-term growth sector in Europe's printer sector.

Japanese competition in Europe is not only a problem for local national printer makers. U.S. manufacturers with European plants face the same challenge. They include IBM, which operates a big facility in Jarfalla, Sweden; Xerox Corp., in Michel Dene, England; Printronix Inc., in the Netherlands; and Dataproducts Corp., near Dublin, in the Irish Republic.

To put the squeeze on the Japanese, the European Community (EC) is demanding that 40% of the value of their printers' components must be made in Europe. Machines which do not meet this requirement risk a tariff of between 20% and 30% when the current EC investigation is completed. A levy of this order would be comparable with the existing duty on low-end copiers with which, until recently, Japan had been flooding Europe.

But the Japanese, who regard a steep levy on their printers as inevitable, are taking counteraction. Over the past few months, they have announced plans to build eight full-fledged printer plants in Europe. Within a couple of years, most of the 2 million printers which Europe today imports from Japan will be made at European sites.

Britain, which offers particularly tempting cash incentives to industrial investors, will be the home of six of these new plants. They will be operated by Brother Industries Ltd., Citizen Watch Co., Seiko Epson Corp., NEC Corp., Oki Electric Industry Company Ltd. and Panasonic Industrial Corp. Ltd. Tokyo Electric Co. (TEC) intends to manufacture in West Germany and Fujitsu Ltd. in Spain. "And that list is not complete," says Al Springsteel, a vice president of Dataquest Inc. and director of the San Jose-based research firm's Western European Printer Industry Service. "At least two or three other Japanese manufacturers intend to follow suit."

The Japanese strategy will mean more jobs for Europe. Before the recent plant decisions, 200 people on that continent were making Japanese-designed printers. Within a year, that number could become 1,200. Three or four years from now, Japan is likely to employ 4,000 workers in its European printer factories. U.S. printer manufacturers already have 3,000 people on their payrolls in Europe.

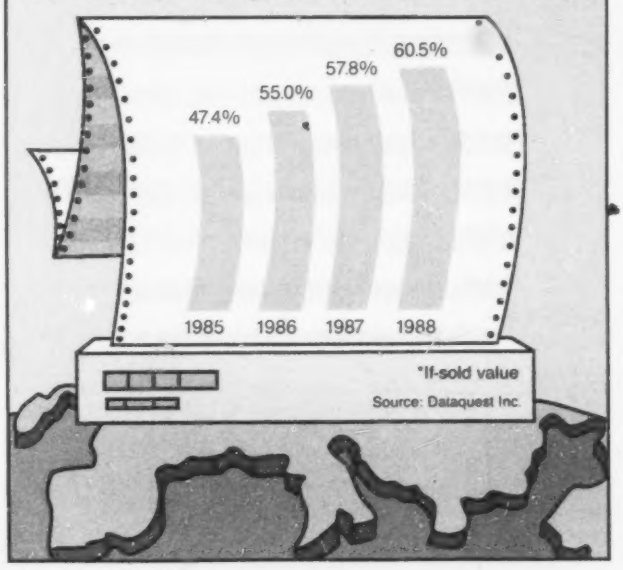
Not necessarily cheers

Good news for Europe's labor force will not necessarily raise cheers among Europe's printer users, who could face significant price increases. To produce locally, Japanese manufacturers will have to shoulder the burden of duplicating facilities, procurements, management, tooling and quality inspection. Also, there is the question of whether European parts are comparable to Japanese parts for either price or quality.

The issue of Japan's alleged printer dumping is dear to the heart of Jürgen Mammitzsch, sales and marketing manager for peripherals at Philips Kommunikation Industrie AG, based in Siegen, West Germany. Mammitzsch, a leading promoter of the Europrint group, says: "Japanese printers cost more in Japan than in Europe. That means they are dumping them over

Europe's printer market is growing much faster than the U.S. market

Estimated value* of Western European printer market as a percentage of the North American market



here. Tariffs are not the best way to solve this problem. But, right now, they are the only solution." He adds: "In the longer term, European manufacturers must learn from the Japanese. We must ensure that we can offer a full range of printers that equal the Japanese quality."

However, Europrint's clamor against the Japanese is not universally endorsed. Says Dataquest analyst Springsteel: "The European community is irritated by its overall $12 billion trading deficit with Japan. But only part of this can be attributed to printers. In my view, it is most likely that the Japanese are not really dumping. On the contrary, they derive considerable advantages from the value of the yen, their energetic and disciplined workforce and their product design concepts. They also have a head start thanks to their mastery of industrial automation, the infrastructure of their component suppliers and their global marketing and production volumes."

EC officials make no secret that, in implementing legislation to control the current trade flow from Japan, they are trying to head off future trade deficits with Korea, Singapore and Taiwan. An official at EC's Brussels headquarters says: "We're taking preventive action against these newly industrialized countries. Otherwise, they too could demand the same lopsided access to European markets that Japan has enjoyed until now."

Don Pinchbeck, general manager of Epson UK, which is based in Telford, England, says: "Japan may be seen as the industrial enemy today. But tomorrow it will be Korea. And, when China's turn comes, who dare cripple that economic giant?"

Ironically, while ganging up on the Japanese, Europrint members are buying printers from their antagonists and selling them under their own logos. Mannesmann Tally, for instance, resells Copal units, and Facit of Sweden markets TEC printers. European manufacturers do not, apparently, see any contradiction in making such deals while sending their lobbyists to EC to demand high duties on Japanese printers.

The market for printers is growing faster in Western Europe than in the United States. Sales in North America peaked at $7.3 billion in 1984. Then they contracted. Since 1985, they have remained stable at around $6 billion. And while shipments in Europe have quadrupled since 1981, they have grown by an annual average of 10% in the United States, a disparity that is explained by Alan Clemmetson, associate director of Dataquest's Western European Printer Industry Service: "In the U.S., 60% of white-collar workers are using desktop computers. In Europe, only 25%. So the European market for both PCs and printers is much further from saturation than that of the U.S," he says.

Although current interest is strongly focused on non-impact technology, impact printers still represented 91% of European sales in units, and 92% in value in 1986. They remain the lifeblood of the industry. Impact printers are continuously improving in quality as manufacturing costs are driven down and performance is enhanced.

According to Dataquest, the 24-wire serial impact dot matrix printer market grew by 146% in 1987, whereas the low-end laser printer market developed by 90%. Hamish Dewar, managing director of Clan Systems Ltd., a Livingston, Scotland designer of laser printer controllers, says: "The way the dot matrix business is fighting back is impressive. And it is essentially cost driven."

The Europeans may be taking action to protect their dot matrix business, but the Japanese could embarrass them by speeding up the introduction of their next generation of low-cost page printers. With only a few exceptions, Europe's manufacturers have spent little or nothing on developing this technology.

JACK GEE

Japan's Scots lesson

The Japanese have mastered the technology of building cost effective engines for laser printers. But they have run into trouble in trying to master the software technology needed to merge text and graphics. To fill the gap, they have turned to firms on both sides of the Atlantic — firms like Clan Systems Ltd. of Livingston, Scotland.

The founders of this electronic design company are Hamish Dewar, a Scot, and Igor Hansen, a Pole, who met during a university research program. Four years ago, while talent scouting for a laser controller, Fujitsu selected prototypes from three U.S. suppliers and one in Europe: a design by Dewar and Hansen. Basically, it resembles a TV screen that produces 8 million dots to a printed page. The controller turns this information into a page intelligible to the printer.

Dewar, who is managing director, says: "Now we are looking to doing enhancements for Fujitsu and other printer manufacturers." Hansen, Clan's technical director, comments: "The Japanese are not yet capable of doing this sort of job. They are surprised how sophisticated the controller for a laser printer is compared with that for a serial printer. It's a major leap in software." □

CLAN SYSTEMS' HANSEN (left) AND DEWAR: Surprising the Japanese with canny software for driving laser printers

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THE NEW SHELL GAME

Where was this U.S. chip *really* made?

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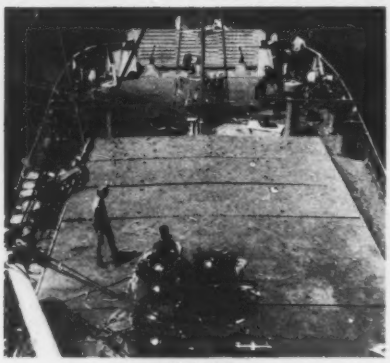

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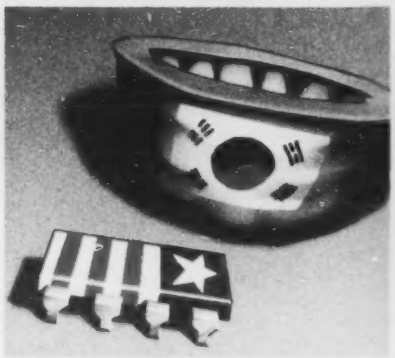

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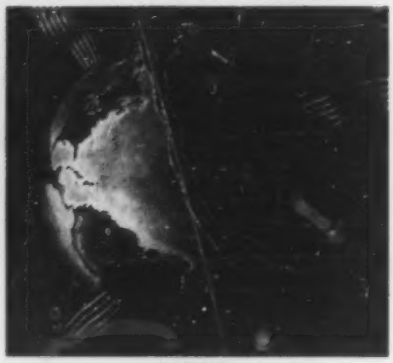

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As computers go, semiconductors used to go

But in 1988, the semiconductor market draws plenty of strength from other markets, such as automobiles

Jack Beedle turned into an optimist with the new year. He upped his forecast for the U.S. semiconductor market in 1988 from 11% to 17%. His optimism is based on a negative factor: the stock market crash of last October. Or, more precisely, on the way the U.S. economy has weathered what he calls "the October 19 tsunami." Beedle sees the economy shifting from consumer demand to industrial demand.

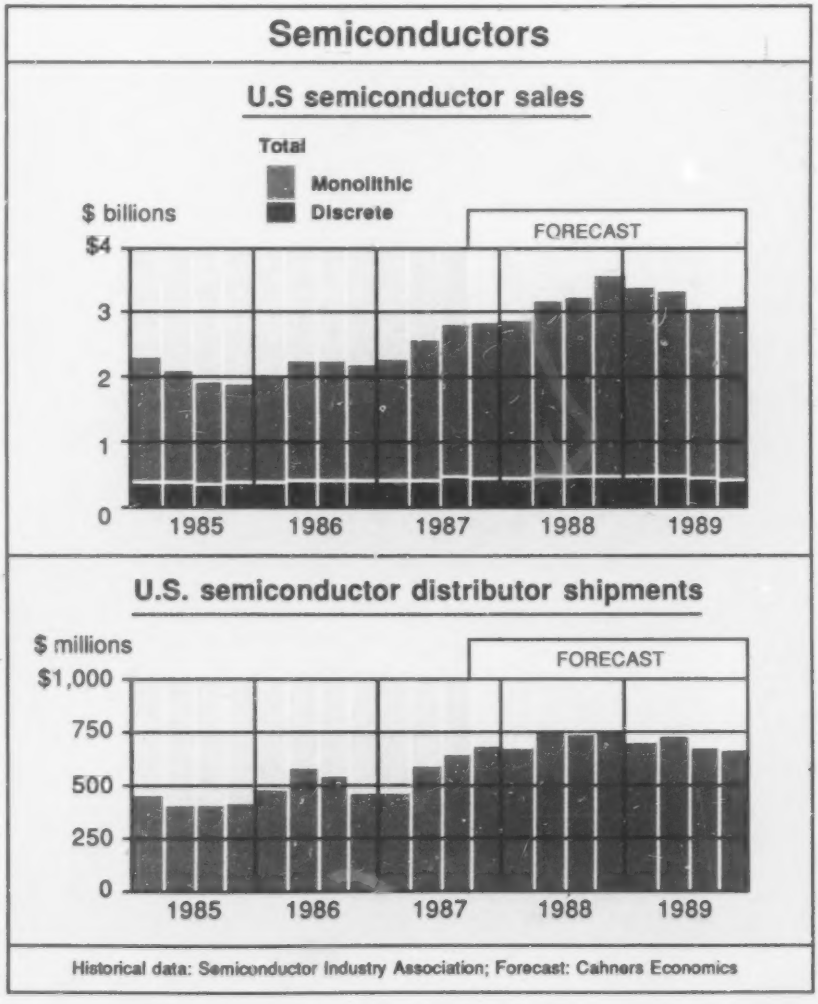
"Exports are up, the dollar is down, computer production went up sharply in the last quarter of 1987," says the president of market research firm In-Stat Inc., which specializes in the semiconductor market. In particular, Beedle found great encouragement in the strong showing by the U.S. market for semis in the last quarter of 1987. At $2.8 billion, it was the highest since the last quarter of 1984, almost 30% higher than the year-earlier quarter, and it pushed 1987 to top the previous year by 22%.

Fourth quarter results by computer and semiconductor companies alike confirm Beedle's newly found optimism. Sun Microsystems Inc. doubled its sales in that quarter; its momentum may push Sun's sales over $1 billion this year. Seagate Technology, which is well on its way to that financial mark, grew by 32%. Among the chip makers, the ASIC manufacturers continued to outperform the rest of the field. One of the leaders in that market, VLSI Technology Inc., saw its sales increase by 37% in that quarter, although that was below the remarkable 54% it registered by finishing 1987 at $172 million. And Silicon Systems Inc., an ASICs manufacturer and a big supplier of chips to Seagate, registered 48% sales growth for the quarter.

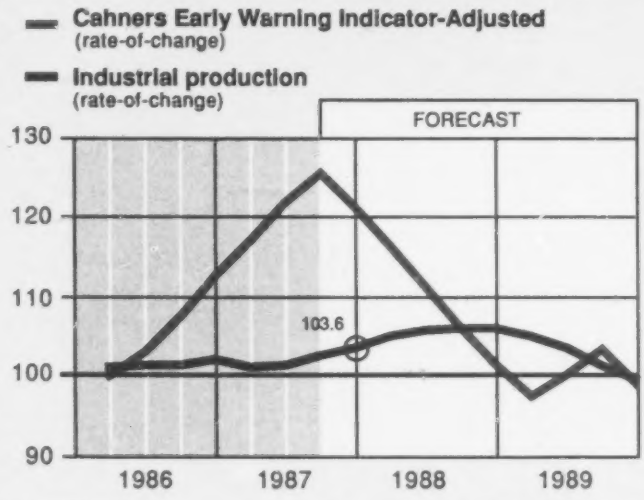
By contrast, Cahners' senior economist Elizabeth Baatz sees trouble where Beedle draws hope. While her forecast for the U.S. semiconductor market has been all along more optimistic than In-Stat's — her latest is for a 28% increase this year — Baatz is concerned with the 18.5% drop that the U.S. Bureau of the Census reported in seasonally adjusted orders for computers and business equipment for last November.

Actually, even Beedle's forecast has a negative side. While U.S. chip makers are glad to see him optimistic ("They're not used to it," he quips), the 17% he forecasts for the U.S. market is less than the growth he sees for the whole world. He has upped his growth prediction for the worldwide market from 10% to 21%. Since the Semiconductor Industry Association, as well as the market watchers, measure the market in dollars, some of that increase derives from the continued strength of the yen. But not all; the rest comes from: Hong Kong, Korea, Singapore and Taiwan.

ALBERTO SOCOLOVSKY



Economic indicators

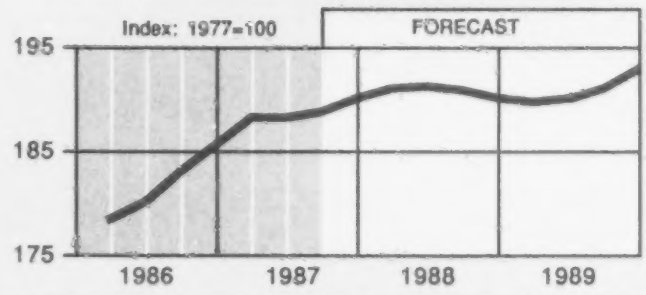


Historical data: Federal Reserve Board; Forecast: Cahners Economics

Industrial production

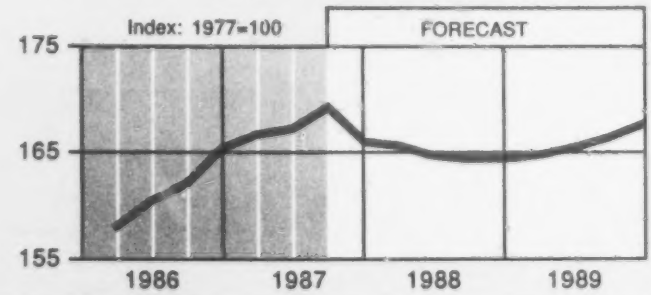
Defense and space equipment

Industrial production (quarterly averages, seasonally adjusted)



Aircraft and parts

Industrial production (quarterly averages, seasonally adjusted)



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. During 1987's third quarter, output rose 2.1% from the prior quarter and was up 3.1% year-to-date compared with last year. This slow and steady growth is expected to continue until this summer. Production is expected to rebound after a year and a half of sluggish growth, pushing production up 6% this year. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar, inventory replenishment and growth in business equipment investment.

The Cahners Early Warning Indicator (CEWI) has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. The CEWI is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2), deflated by the Consumer Price Index. The CEWI has proven to be an excellent tool in forecasting the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That change over a 12-month period can be determined by comparison with the line at 100. For example, the 106 level forecasts using the CEWI for the end of this year indicates that the average for all of 1988 should be 6% above 1987.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St. Newton, Mass. 02158.

Defense budget tightens

A softening in defense production was already evident by the end of 1987. Output grew about 4% in 1987 and will slow down to 1% growth in 1988. National defense purchases grew about 9% in 1987, down from 12% in 1986 and 15% in 1985. The silver lining in the slow growth scenario is that the push to modernize the armed forces will keep the electronics portion of the defense budget growing.

Aircraft production outlook darkens

The production outlook for aircraft, missiles and parts is in sharp contrast to the recovery in other electronics industry. In mid-1986, when most other electronics industries slumped, growth in the rate of aircraft production peaked. Output of aircraft rose just 4% in 1987, a disappointing performance after the soaring growth rates of the previous few years. Cahners Economics estimates aircraft production will drop 1.5% in 1988.

The new shell game

Where is this U.S. chip *really* made? Even the major American chip makers are subcontracting out more and more of their production

The fabless semiconductor company is not a new phenomenon. For years, Silicon Valley has witnessed a sprouting crop of companies that have shunned manufacturing. Fledgling firms like Altera Corp., Chips and Technologies Inc., Vitelic Corp. and Xilinx Inc. are but a few examples of U.S. chip start-ups that have concentrated on the design side of the business, leaving their manufacturing for others to do.

At first, these fabless start-ups were mocked. "Real semiconductor companies have fabs," sneered some in the industry [ELECTRONIC BUSINESS Aug. 15, 1987, p46]. But if imitation is the truest form of flattery, the start-ups now have reason to feel smug. Many major U.S. chip makers — Advanced Micro Devices Inc. (AMD), Intel Corp. and National Semiconductor Corp., chief among them — confess that they are now farming out more and more of their manufacturing. In fact, Intel will subcontract out between 20% to 30% of its total production this year, says David L. House, senior vice president.

Many in the industry see this trend continuing. However, few are foreboding the day when any of the major U.S. chip companies wind up as fabless operations. Still, the advantages of subcontracting are as appealing as they are compelling and no one seems to know just when this trend will peak.

Sending one's unfinished chips elsewhere to be assembled and packaged by another company has long been a widespread practice. Many assembly houses in Asia have flourished by doing the back-end manufacturing for their American customers. Roughly 25% of all U.S. chip assembly is done by approximately 30 subcontractors in South Korea, Hong Kong and the Philippines, according to Richard W. Martin, president of contract assembler Indy Electronics Inc. of Manteca, Calif.

In addition to assembly and packaging, many major U.S. chip companies are now using subcontractors for front-end manufacturing as well. These subcontractors, typically called foundries, will do the silicon wafer processing for customers. The chip foundry business is already a $600 million industry, according to Integrated Circuit Engineering Corp. (ICE), a market research firm located in Scottsdale, Ariz. San Jose-based Dataquest Inc. puts the figure even higher, at $940 million for last year, rising 27% to $1.2 billion this year.

A touchy topic

Many U.S. chip executives hesitate to talk about their subcontracting activities. By admitting that their products are being manufactured elsewhere, they risk the implication of being inefficient. Furthermore, chip subcontracting is a particularly touchy subject because the bulk of foundry work is being done outside of the United States. According to ICE's figures, foundries in Asia do 58% of the world's subcontract work.

Motorola Inc., headquartered in Schaumburg, Ill., subcontracts "absolutely none" of its wafer processing, insists Jack W. Browne Jr., manager

products. Browne ... concede that Motorola ... "very little" of its ... and packaging work. "Less than 5%," he says, strongly maintaining that "to really be competitive, you've got to supply it yourself."

Browne is challenged by some who contend that Motorola's usage of contract assemblers is much more involved. Independent sources argue that Browne's "less than 5%" figure is really at least twice that amount. In fact, a former employee states that Motorola sometimes subcontracts as much as 20% of its back-end manufacturing.

Kevin McGarity, a vice president of Texas Instruments Inc.'s semiconductor division, will not quote an exact figure for subcontracting at his company, but says it's a "relatively small percentage." McGarity acknowleges that "We use subcontracting as a supplement to our own manufacturing." Indeed, South Korea's Hyundai Electronics Industries Company Ltd. and Japan's NMB Semiconductor are both currently making memory chips for TI.

Similarly, South Korea's Samsung Electronics Company Ltd. and Japan's Mitsubishi Electric Corp. are manufacturing chips for Intel Corp. of Santa Clara. Says senior vice president House: "We've been increasing our subcontracting over the last two to three years. It used to be a few percentage points before and now it's over 10%." House expects the figure to rise to somewhere between 20% to 30% by the end of this year and possibly higher in the future. "We might not stop at 30% but our objective is not to go to 100%," he says.

AMD has tighter reins limiting the company's subcontracting. "I would not see it growing, under any reasonable scenario, to more than 30%," says Gene Conner, a senior vice president of the Sunnyvale, California-based chip manufacturer. Currently, AMD subcontracts out less than 5% of its manufacturing. Conner expects this portion to rise to perhaps 25% within the next three to five years.

Even manufacturing powerhouse National Semiconductor engages in significant subcontracting activities. Raymond Farnham, vice president for advanced logic products, says that his company's use of subcontractors is also on the rise. The current figure at National Semiconductor is around 10%.

Some companies that have not yet jumped on the subcontracting bandwagon may do so in the near future. Harris is currently doing all of its wafer fabrication in-house, according to Russell Morcom, vice president and general manager of semiconductor products. However, Morcom says, "We know that there are a lot of good sources out there for wafer fab." Consequently, he expects to start using foundries this year. He says that Harris will probably subcontract out a maximum of 5% to 10% of its wafer fabrication in addition to the 15% to 20% of assembly work that the company is already farming out.

Roughly 25% of all U.S. chip assembly is done by about 30 subcontractors in Korea, Hong Kong and the Philippines

Richard Martin of Indy Electronics

Why the Koreans are happy

Several Korean semiconductor companies relish the opportunity to do foundry work. In fact, such work is often preferred over a licensing agreement, which is a mere transaction of money in exchange for the right to manufacture a certain product. In contrast, a foundry arrangement entails the customer company teaching the foundry company how to manufacture the contracted product. "Foundry work is more desirable because it helps you to stabilize your manufacturing technology much more quickly," says Park Kwang Oh, a vice president in charge of semiconductor R&D for Hyundai.

Accordingly, Hyundai, a relative newcomer in the electronics business, entered into a host of foundry deals with experienced chip companies, TI chief among them. The work helped busy Hyundai's three new fabs, for which the company invested nearly a half a billion dollars.

But therein lies one danger in using foundries: the possibility that they may become competitors in the future. "You really have to ask yourself: Long-term, am I creating more monsters?" muses Intel's House. "It concerns me whether our foundries will remain happy in their role as just manufacturers or if one day we'll see them as across-the-board competitors."

TI executives may be asking themselves the same question about their foundry agreement with Hyundai. Clearly, the Korean behemoth is aching to become a world leader in the merchant semiconductor market. In the past, 80% of Hyundai's production was foundry work, according to Park. The figure has since fallen to 50% and Park says that it will continue falling in the future. He asserts that his company will one day break into the top 10 list of worldwide semiconductor companies.

The Japanese are also winners in the subcontracting game because of

Who makes what for the top five U.S. semiconductor makers

Company	Foundry	Products subcontracted
Texas Instruments	NMB Semiconductor Hyundai	Frame RAMs 256K DRAMs
Motorola	Toshiba	256K DRAMs*
National Semiconductor	NMB Semiconductor Hyundai	SRAMs
Intel	Mitsubishi Samsung	EPROMs DRAMS*
Advanced Micro Devices	Several Japanese companies	Not available

* Technically a supplier-reseller relationship

Source: ELECTRONIC BUSINESS

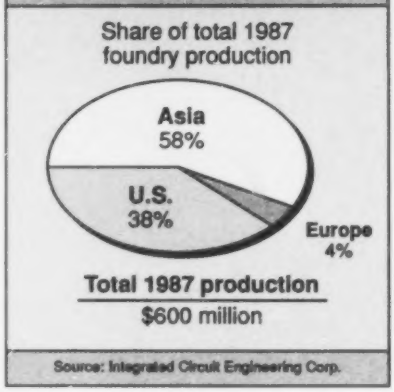
their shrewd bargaining practices. In exchange for manufacturing other companies' chips, many Japanese foundries have exacted technology rights from their U.S. customers [ELECTRONIC BUSINESS Feb. 15, 1986 p32]. Xilinx of San Jose had to divulge its innovative chip technology to Seiko Epson Corp. of Japan in order to get a manufacturing promise. In a similar agreement, WaferScale Integration Inc. of Fremont, Calif., disclosed its proprietary CMOS know-how to Sharp Corp. of Japan.

The Koreans and Japanese are not the only ones doing subcontract work. National Semiconductor's Farnham says that of his company's total production, approximately 10% is manufacturing done for other companies. Farnham sees the figure increasing in the future. Indeed, National is considering a reentry into the DRAM chip market by doing foundry work. And Intel received some of Altera's erasable programmable logic device technology in exchange for doing some foundry work for the Santa Clara, California-based start-up.

As with the back-end manufacturing business, where independent subcontract assembly companies like Indy Electronics have thrived, independent foundries like the Taiwan Semiconductor Manufacturing Company Ltd. [ELECTRONIC BUSINESS Jan. 15, 1988] may also flourish. Established in 1986, TSMC is already seeing a huge demand for its foundry work. In fact, business has been so strong that the company is planning to invest $220 million this year on an additional production facility to supplement its first fab, which cost more than $100 million.

TSMC executives claim that they run the world's first major independent foundry. Independency has its advantages, claims Steve Pletcher, company vice president for marketing. According to him, "We know that we've had success this year because we don't compete against our customers.... We've actually had people come to use us because the foundry that they've had a longtime relationship with has now become a competitor and come out with products which are very, very similar to the products that they've been foundrying. The fact that we have no design engineering and no end products has been an asset."

No prizes for guessing who rules the world's foundry business



Expecting to be cloned

Because of TSMC's success thus far, Pletcher says, "We expect to be cloned." In fact, Pletcher adds, "We hear rumors coming out of both the U.S. and Japan that there are people putting together business plans to clone us."

Critics, however, question whether TSMC's success is due to an industry trend favoring independent foundries. Gene Norett, in charge of semiconductor market research for Dataquest, credits TSMC's success instead with the company's seasoned management team of chairman Mor-

The pros and cons of subcontracting

Semiconductor industry executives cite two main reasons for the increasing popularity of subcontracting:

1. The semiconductor market by nature is cyclical and volatile. By using subcontractors, a chip company can quickly ramp up or ramp down its production to handle better the market's vagaries. Because of the increasingly high cost of semiconductor capital equipment — a single piece of lithography machinery currently tops $1 million — companies are now finding that they *must* keep their fabs busy. "There's truth to the saying that a fab is like a pet dinosaur: If you don't keep feeding it, it'll eat you," quips Mark Reagan, analyst for Dataquest Inc. of San Jose.
2. Subcontracting provides for better leveraging of capital. Intel Corp. is farming out the production of its commodity-like memory chips in order to concentrate on making state-of-the-art microprocessors which command premium prices. Using subcontractors also frees up one's R&D budget. "Subcontracting allows us to use our cash to get ahead instead of simply to harvest," says David L. House, Intel senior vice president.

In addition, foreign subcontractors often can manufacture a product at lower costs, a fact that most U.S. chip executives are loathe to admit. "It's tough competing against the labor rates in Southeast Asia," says Jack Beedle, president of In-Stat Inc. of Scottsdale, Ariz.

The benefits of subcontracting notwithstanding, few in the industry are predicting that the U.S. chip industry will ever end up fabless. "In order to be a major player in the worldwide semiconductor market, it is imperative that you must have a major manufacturing capability.... Anybody that does not have that commitment is susceptible to becoming a lesser player in the long run," insists Gene Conner, senior vice president of Advanced Micro Devices Inc. of Sunnyvale.

Many industry executives assert that the synergism between design and manufacturing is absolutely necessary. "If I have enough control over my manufacturing, then I can get 5% or 10% more out of the products I design. And even 5% in a head-to-head competitive challenge is a lot," says Jack W. Browne Jr., manager of the microprocessor products group for Motorola Inc., headquartered in Schaumburg, Ill.

Besides, subcontract arrangements do not always run smoothly. Vitelic Corp., a fabless start-up located in San Jose, is reportedly one year behind schedule because of a problem-plagued relationship with foundry Hyundai Electronics Industries Company Ltd. of South Korea. "In dealing with a company like Hyundai, it's not just a matter of transferring the technology and design over there; you also have to solve their manufacturing problems too. And that is why it's been so time consuming," says Alex Au, Vitelic president. □

Why I moved to California

Last January, Steve Pletcher uprooted his family and moved from Florida to Silicon Valley. Pletcher, marketing vice president for Taiwan Semiconductor Manufacturing Co. Ltd. (TSMC), made the transcontinental trek in order to relocate his company's U.S. operations from St. Petersburg to San Jose.

A year ago, Pletcher did not think he would now be living in California. At the time, Pletcher thought that much of TSMC's chip foundry business would come from captive semiconductor makers — companies such as computer manufacturers that make chips for their own internal usage — and from other major chip consumers.

Little did Pletcher suspect that the vast majority of TSMC's sales would instead come from the merchant chip manufacturers, companies like Motorola Inc. and Texas Instruments Inc. "We always felt that the merchant semiconductor companies would probably be at least 50% of our business, but we never thought that it would be 95%," says Pletcher. Which is why TSMC moved its U.S. beachhead to Silicon Valley, heartland of America's merchant semiconductor industry. □

ris Chang — ex-TI vice president — and president James E. Dykes, former head of General Electric Co.'s semiconductor operations. "The jury's still out on how successful independent foundries will be," says Norrett. "People use foundries as a buffer and the acid test is: what will happen when the next chip downturn occurs?"

Indeed, that is the question that many industry executives are now asking themselves. It is easy to see why subcontracting would flourish in a market upswing when vendors are scrambling to keep up with demand. But just how the foundry and contract assembly industry will hold up during the next chip recession is a subject for debate.

Nonetheless, U.S. chip industry executives now seem to have an altogether different attitude toward subcontractors than they had in the past. "Foundries and assembly houses have often been considered by management to be a safety valve: If I have to ramp up quickly, I will ramp up my subcontractors. When I have to ramp down quickly, I will ramp down my subcontractors. We've seen that attitude *definitely* change," says TSMC's Pletcher.

Pletcher claims that companies like Intel, National Semiconductor and TI now view their subcontractors as key strategic partners. "I've talked to many of the top U.S. semiconductor manufacturers and all of them now have a definite foundry strategy which was unheard of a few years ago," says Pletcher. Accordingly, TSMC has negotiated long-term contracts, of three to five years, with all of its customers.

Certainly, the next chip recession will test the mettle of these new partnerships between chip companies and their subcontractors. Be that as it may, the alliances should survive because both parties appear strongly committed to each other. "If you cut your foundry off cold in a downturn, you can expect him to do the same to you in an upturn," says Intel's House. "You've got to have a plan where you keep your subcontractors active even during slowdowns." Consequently, House says that, with any foundry agreement, "We look for marriages, not affairs." Because of the strengthening relationships between chip companies and their subcontractors, Mark Reagan, Dataquest research analyst, asserts, "The foundry business is here to stay." □

Top semiconductor manufacturers

Estimated 1987 rank	1986 rank	Company	Worldwide semiconductor sales ($ millions) Estimated 1987	1986
1	1	NEC	$3,240	$2,560
2	2	Toshiba	$2,980	$2,270
3	3	Hitachi	$2,560	$2,160
4	4	Motorola[1]	$2,380	$1,960
5	5	Texas Instruments	$2,050	$1,800
6	10	National[2]	$1,725	$1,525
7	6	Philips[3]	$1,550	$1,325
8	7	Fujitsu	$1,450	$1,145
9	8	Matsushita	$1,435	$1,145
10	12	Intel	$1,230	$880

[1] Includes about $150 million of nonsemiconductor sector packaging (nonhybrid)
[2] Includes Fairchild
[3] Includes Signetics

Conversion rates:
1986: ¥170 = $1
1987: ¥145 = $1

Source: Integrated Circuit Engineering Corp.

TOP FOREIGN COMPANIES IN THE U.S.

The slumping dollar drags foreigners' sales with it

To deflect worse dollar wounds, overseas firms are freezing prices, cutting production costs and setting up U.S. plants

By Theresa Engstrom and Linda Stallmann

This year, N.V. Philips GL replaced Matsushita Electric Industrial Co. as the foreign electronics company with the most business in the United States — but only by dint of its dogged defense against the common enemy — the falling dollar.

Foreign sales of electronic goods to the U.S. market reacted drastically to the dollar's continuing slide. The impact was evident from the trade figures: In 1985, when the dollar peaked at 260 yen, Japanese firms exported about 40% of their total production to the United States; the percentage is now about 33% and headed lower.

As a group, Japanese firms took the brunt of the attack. Matsushita's sales of goods to the United States were $3.7 billion, virtually flat compared with last year's report. Mitsubishi Electric Corp., Nippon Electric, Sanyo Electric Company Ltd., Sharp, Sony Corp. and Toshiba Corp. — all listed among the top 10 firms — reported flat or lower sales to the United States.

The dollar has put pressure on Japanese firms to freeze prices, cut production costs through automation, and aim for higher-priced markets. Some companies are establishing plants in newly industrialized countries to cut costs, or in the United States to forestall angry political action.

Besides the political implication, the cheaper dollar has given foreign firms such as Matsushita an economic incentive to site a plant in the States. Real estate and construction costs are cheaper these days than at any time in the past several years,

The dollar has put pressure on foreign firms to freeze prices, cut production costs through automation, and aim for higher-priced markets

and moderate increases in U.S. labor costs over the past few years have removed much of the wage differential between the United States and Japan.

On the one hand, this favors U.S. producers. "The dollar's depreciation has given U.S. manufacturers an absolute competitive advantage over Japan," says Sara Johnson, senior economist at Data Resources Inc., Lexington, Mass., who expects a continuing, albeit moderate, decline in the dollar. However, Johnson points out that east Asian countries — including Korea, Taiwan, Singapore and Malaysia — whose currencies are tied to the dollar, enjoy a twofold advantage: a weak currency and truly cheap labor.

The sharpest companies have tried to anticipate such scenarios. N.V. Philips' sales increased 6% in the fiscal year ended December 1986, although that figure declined about 5 billion guilders when expressed in the Dutch currency because of the dollar's 26% depreciation against the guilder. "Needless to say, such a huge decline has a considerable adverse impact on both the competitiveness and the translation of the sales and income of the company, which is increasingly active in the United States and in dollar-linked regions," write sC.J. van der Klugt, president of Philips, in his report to shareholders.

Reducing parts counts

Philips' profit picture was improved somewhat by the sale of some subsidiaries. However, the company also brought on-line its optical media division; and color televisions, video recorders and compact disc players contributed to a 14% increase in its sales of consumer electronics prod-

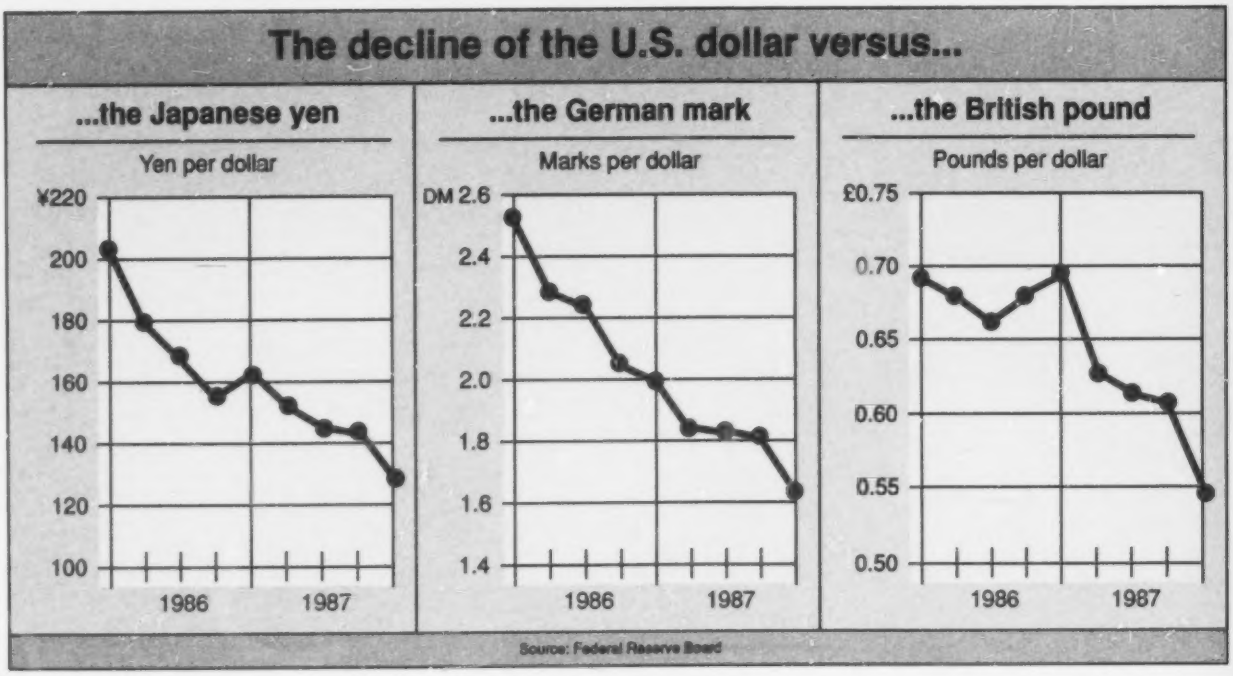
Tom Barrett

Top foreign companies in the U.S.

Rank 1987	Rank 1986	Company	U.S. electronics sales ($ millions) 1987-1986	1986-1985	1987-1986 total consolidated sales ($ millions)	1987-1986 profit before taxes ($ millions)	Fiscal year ended	Country of origin
1	2	Philips	$3,993	$3,430	$25,131	$894	12/86	Netherlands
2	1	Matsushita	3,700	3,700	28,067	2,706	11/86	Japan
3	3	Hitachi	3,030	2,920	33,210	1,769	3/87	Japan
4	4	Northern Telecom	2,860	2,876	4,384	441	12/86	Canada
5	5	Sony	2,634	2,250	8,180	472	10/86	Japan
6	6	Toshiba	2,000	1,500	22,655	534	3/87	Japan
7	7	NEC	1,948	1,450	16,779	398	3/87	Japan
8	8	Sharp	1,600	1,400	7,868	293	3/87	Japan
9	9	Siemens	1,500	1,340	23,261	1,518	9/86	West Germany
10	10	JVC	1,335	1,200	4,839	136	3/87	Japan
11	13	Mitsubishi	1,200	1,000	14,435	261	3/87	Japan
12	11	Sanyo	1,200	1,200	7,246	77	11/86	Japan
13	16	Fujitsu	1,170	650	12,256	329	3/87	Japan
14	12	Canon	1,150	1,090	5,523	172	12/86	Japan
15	14	GEC	1,100	980	8,395	1,069	3/87	Britain
16	28	CGE	865	320	12,589	423	12/86	France
17	17	Olivetti	835	620	5,452	537	12/86	Italy
18	18	Samsung Electronics	800	550	16,967	256	12/86	Korea
19	21	Kyocera	542	465	1,892	259	3/87	Japan
20	19	C. Itoh	500	500	101,112	152	3/87	Japan
21	20	Racal	475	470	2,065	160	3/87	Britain
22	26	Pioneer Electronic	470	390	2,253	91	9/86	Japan
23	24	Oki Electric	460	400	2,791	28	3/87	Japan
24	15	Schlumberger	450	900	4,938	-1,760	12/85	Netherlands
25	22	TDK	450	430	2,367	222	11/86	Japan
26	25	Lex Services	442	390	1,623	39	12/86	Britain
27	23	Thorn EMI	430	430	5,096	255	3/87	Britain
28	30	Thomson-CSF	425	300	5,610	422	12/86	France
29	29	Ericsson	400	310	4,671	134	12/86	Sweden
30	47	Bayer	370	NA	21,141	1,712	12/86	West Germany
31	32	Alps	325	240	2,532	98	3/87	Japan
32	31	Plessey	280	260	2,288	295	3/87	Britain
33	27	Commodore	230	360	807	32	6/87	Bahamas
34	33	Brother Industries	185	138	1,034	60	11/86	Japan
35	48	Bosch	180	NA	11,268	782	12/86	West Germany
36	39	AEG	140	100	5,821	NA	12/86	West Germany
37	34	Mitel	139	130	326	-1	3/87	Canada
38	35	Nixdorf	130	130	2,336	364	12/86	West Germany
39	38	Mannesmann	120	110	8,941	268	12/85	West Germany
40	37	Canadian Marconi	98	110	164	28	3/87	Canada

U.S. electronics sales are ELECTRONIC BUSINESS' estimates. All figures are converted at the exchange rates at the end of the fiscal years, thus a variety of accounting and exchange rates are represented.

Source: ELECTRONIC BUSINESS



ucts. In its consumer electronics line, Philips is striving to "reduce the part count," says a spokesman — thus reducing the cost of production.

Matsushita had some good news, some bad. The yen's strength meant that overseas sales of the company's products fell 20% in 1986 to about 44% of the total. But the company added several new American production facilities to its existing string, including a video tape recorder plant in Washington state and a facility for making car stereos in Georgia. Despite lower capital investment, Matsushita increased its investment in research and development 4%, to about $1.5 billion, which is 5.5% of sales. "Day to day efforts" are being made to reduce operating costs, says Ken Shimba, public relations manager of Matsushita Electric Corp. of America.

Another tactic is to aim for more profits per product. Matsushita is moving toward more products with higher value-added in order to avoid competing in the war-torn low end of the market, says Shimba. For example, he says, Matsushita's Panasonic division is pushing a more expensive video cassette recorder with a scanner that will read bar codes printed in a special directory of viewing schedules. The company hopes that eventually *TV Guide* magazine will include bar codes.

Northern Telecom Ltd., based in Canada, had a happier story to tell. Chairman Edmund B. Fitzgerald reported a 5% increase in earnings, the result of a strong second half that offset a 23% decline in the first six months of 1986. The company focused on improving manufacturing, marketing and research, especially for the "extremely competitive North American business communication systems market," where it sells 95% of its product.

Sony hit hard

Sony, conceding it was hit hard by a difficult United States sales climate as well as by the yen, decided in early January to raise prices on many of its electronic products, following in the footsteps of Matsushita. With overseas sales accounting for more than 70% of sales, Sony had reported a 7% drop in sales, and an 11% drop in overseas sales for fiscal year 1986. This was particularly hard to take considering the company's performance in the U.S. market; when measured in local currencies, Sony's U.S. sales grew 24%. However, deteriorating profits resulted in a 75% decrease in operating income, mostly from poor export profits, according to Sony chairman Akio Morita. One defense tactic adapted by Sony was the redesign of many of its products to include fewer parts, as well as automating production facilities, and streamlining distribution channels.

Toshiba's 43% decline in net income was blamed partly on 100% tariffs on personal computers, color televisions, and electric tools imported from Japan. To counter the trade barriers, the company began producing more of its products locally, and increased its shipments of value-added devices such as application-specific integrated circuits.

The firm also formed strategic alliances with companies that have footholds in their native markets: A trilateral program with the United States' General Electric Co. and Germany's Siemens AG, for instance, has been formed to develop standard-cell libraries for application-specific ICs. A separate agreement with Motorola Inc. will result in jointly produced advanced microprocessors and memories for the Japanese market.

With such alliances becoming more common, analysts agree that political action in the United States counts for little, compared with the ingenuity of firms that truly have an international mindset. "Any trade bill produced by Congress is expected to be vetoed by the president," says DRI's Johnson. However, she adds that trade bills make little difference in today's climate. Offshore production facilities; diverse and flexible sourcing patterns; automation of design and production facilities; cooperative agreements with trading partners of different nations: all have transformed the face of world trade to one that is neither American nor Japanese, but distinctly supernational. □

PASSIVE COMPONENTS

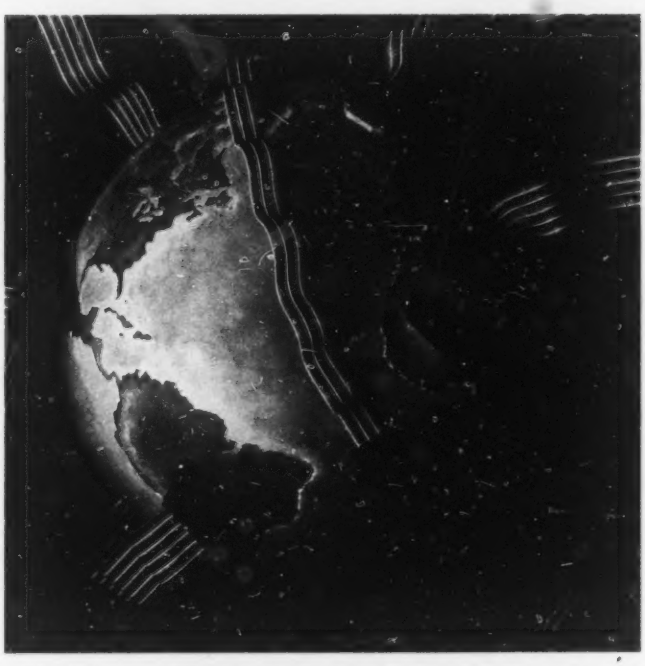
Sudden switch: Fast chips need speedy interconnects

New materials, multichip modules and surface mount technology keep signals flowing swiftly between chips

By Michael R. Leibowitz

Smaller, denser, faster. Those three words sum up the forces driving equipment makers to change the ways they assemble electronic components into electronic systems. A whole new range of interconnect technologies has arrived to satisfy customers' overwhelming preference for the smallest products, the fastest products and the ones that are most laden with features.

Thank the increasing density and speed of integrated circuits (ICs) for the changes rippling through the interconnect area. As chip makers routinely pack hundreds of thousands of devices on an integrated circuit, faster technologies and materials are forcing signals to switch as quickly as a nanosecond or less. The new approaches to interconnect pursue a single goal: take most advantage of the chips' benefits when you tie them together. Do not dampen switching speeds; do not add unnecessary nanoseconds of interconnect delay; and squeeze out the excess space from around the components.



Martin Cooke

New approaches to interconnect pursue a single goal: take most advantage of the chips' benefits when you tie them together

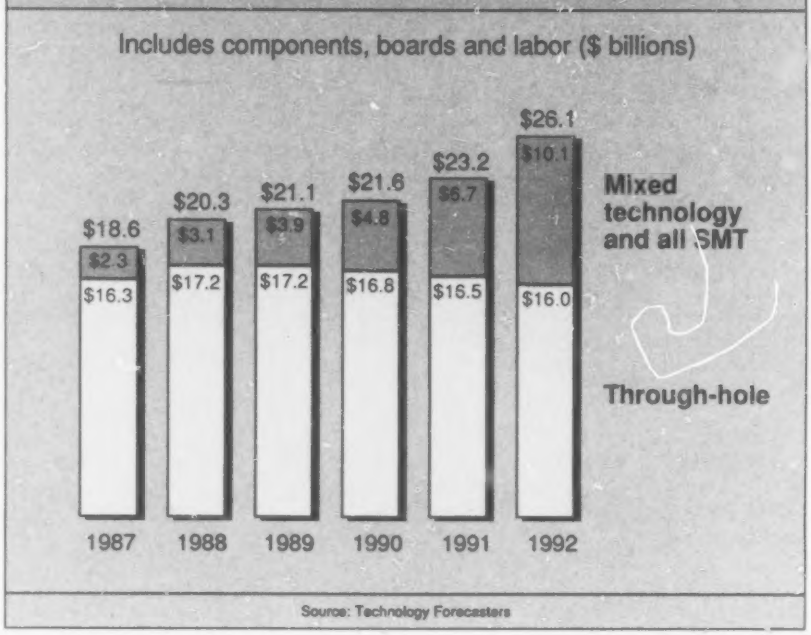
Of all the new interconnect trends, surface mount technology (SMT) is the most important. For years, the technology that offers a threefold increase in density by mounting components on the surface of boards instead of through-holes had idled, remaining the primary domain of a small number of large systems makers and contract manufacturers. In the past year, however, SMT has made great strides in the United States toward becoming a mainstream interconnect technology.

In 1987, SMT production machinery makers witnessed a 15% to 20% growth in demand over the previous year, according to Pamela J. Gordon, president of Technology Forecasters, a Berkeley, Calif., market research firm. And the value of circuit boards produced with SMT in the United States last year surged to $18.5 billion, or 12% of total board production, up from 9% in 1986. Gordon expects this number to climb to 39% by 1992.

SMT growth was impeded until recently by a number of factors: a scarcity of surface-mountable components, nonexistent standards and lack of experience by users. According to Charles-Henri Mangin of Ceeris International, an electronic assembly consultant based in Old Lyme, Conn., manufacturers have been reluctant to invest in SMT production lines, which often cost in excess of $1 million. "That's a big investment," he says, "especially considering the amount of brand new through-hole equipment [already] on the factory floor."

Much of this is changing. Users report an improved variety of SMT components, lower costs, and better manufacturing yields as they gain experience with the intricate SMT process. Although in many cases, SMT-produced boards still cost somewhat more than their through-hole counterparts, the gap is narrowing, and some users have either matched their through-hole costs with SMT or ex-

The rise of SMT in U.S. board assembly production



Source: Technology Forecasters

pect to do so soon.

But, according to experts, one very important factor boosting the acceptance of surface mount in this country is the need for the United States to remain competitive with overseas equipment makers, many of which have already adopted SMT. Small size and increased functionality offer the competitive edge, U.S. producers realize. Besides its basic density advantages, SMT allows product designers to use the latest generation of very dense, high pin-count ICs, which are packaged in packages having only .025-inch center spacing between leads.

James Mitchell, president of Quad Systems Corp., a Horsham, Pa., maker of SMT pick-and-place machines, points out that acceptance of SMT by the Japanese has reached 70% to 75%, up from 50% a year ago and 35% two years ago. "They were taking out through-hole lines and replacing them with surface mount lines," he says.

But U.S. equipment makers are also making the transition. James Elliott, director of advanced manufacturing for Western Digital Corp., says that by July, his company will have spent $35 million on five SMT facilities capable of producing 10 million SMT boards per year. At that point, over 85% of Western Digital's board production, which includes disk controller cards and add-ins for IBM personal computers, will be in SMT.

Industry observers say more and more U.S. electronic equipment makers are following suit. Gordon says 900 companies possess SMT capability already, with many more using SMT through contract manufacturers. She expects 200 to 250 more to achieve SMT capability in 1988. Says Ceeris' Mangin: "Since the competition has it and the market wants it, we don't care about the cost. That's not the issue."

Impedance-matched circuits

Exotic materials and components are becoming mainstream interconnection tools as equipment makers boost system clock rates into the hundreds of megahertz and beyond.

The reason is physics. Conventional circuit board materials, cabling and connectors provide a "transparent" interconnection for slow- to medium-speed signals. These interconnections, however, can appear to fast signals as a bottleneck that reduces speed, or worse, as an obstruction that can cause the circuit to malfunction. And high-speed circuit makers find conventional PCB materials foil much of their circuit cleverness by delaying the propagation of signals, degrading the rise times of signals and causing signals to cross between adjacent PCB traces.

The first solution, for many equipment makers, is to replace conventional interconnect materials with impedance-controlled products, such as precision PCBs, flexible circuits and

PTFE gives PCBs a very low dielectric constant, a quality which makes signals travel faster and experience less loss

impedance-controlled connectors.

And sales of these products are booming, according to Philip Lapin, with Electronic Market Consultants of Redwood City, Calif. Lapin estimates that precision, impedance-controlled PCBs for the U.S. computer industry tallied $300 million to $400 million in sales during 1987, or 20% to 25% of the total computer PCB market. He expects this figure to grow as much as 14% per year over the next several years.

The impedance-controlled interconnect market features competitors such as Rogers Corp. of Rogers, Conn. and E.I. du Pont de Nemours & Co. of Wilmington, Del., which manufacture precision PCB laminates for fabricating multilayer PCBs that maintain tight tolerances on laminate thickness and dielectric constant — key factors that influence PCB impedance. These companies also manufacture flexible circuits and connectors for maintaining a constant impedance when routing signals between boards.

The next step in high-speed interconnect — for particularly fast circuits — is to shift to expensive PCBs made with polytetrafluoroethylene (PTFE), the generic name for DuPont's Teflon frying pan coating. PTFE gives PCBs a very low dielectric constant, a quality which makes signals travel faster and experience less loss: traces can be placed closer and not be subject to "crosstalk." Key players in the PTFE market include Rogers, W.L. Gore and Associates Inc., of Newark, Del., and Keene Corp. of East Providence, R.I.

Analyst Lapin pegs the 1987 value of PTFE-based PCBs at $120 million and expects it to grow 15.5% over the next several years. Military applications, such as radar and missle systems, represent 65% of the PTFE business, with telecommunications following at 20%. But computer applications, at 5% of the PTFE market, comprise the fastest growing segment, expanding 21% a year.

Rogers' Lockard sees a great potential demand for his [illegible]'s new RO2800 low-dielectric laminate

among performance-oriented mini, mainframe and supercomputer makers. "The large computer companies, who have never bought Teflon boards before, are considering them for future systems," says Lockard.

However, equipment makers pay a premium to build boards of this material: RO2800 runs roughly 10 times the cost of standard glass-epoxy material, says Lockard. Still, "our business is growing very rapidly," he reports. Although no customers are yet using this material in production, Lockard expects the evaluation purchases from computer makers to turn into production-level buys between late 1988 and 1990.

For high-performance computer makers, the only way to speed the circuit up is by reducing the interconnection distance between ICs. For them, and for a small number of mostly military contractors for whom space is priceless, a new technology has emerged that is expected to gain popularity in the coming years. The multichip module is expensive, but for those who need the ultimate in performance or density, experts say it is the closest thing to having the entire system condensed onto a single silicon wafer.

Multichip modules are either pieces of ceramic or wafers of silicon on which the interconnecting traces are etched, by what is essentially a semiconductor fabrication process. After the module is fabricated, ICs are attached and bonded and the ensemble is tested. The result is functionally equivalent to a populated printed circuit board — but much faster and a dazzling one-sixth of the size.

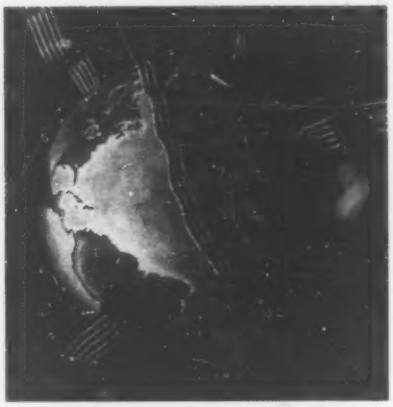
Jack Balde, president of Interconnection Decision Consulting, a Flemington, N.J., packaging consultant, says there is great interest in multichip modules among performance-oriented computer makers and the military. "There is a tremendous amount of action taking place behind the scenes," says Balde. "Not many articles appearing, but it's going to be the explosive area."

And BPA Ltd., the market researcher, projects that worldwide consumption of multichip modules will mushroom from $50 million last year to $400 million in 1990.

Experts say that part of the new multichip activity is spurred by rumors that the Japanese are investing heavily to put them in computer equipment. "Our customers are scared to death that they'll be beaten out by the Japanese," says Clyde Lofdahl, business manager of Raychem Inc.'s multimodule operation.

Many systems makers are mum about their work with multichip modules — much of it now in development stages. But according to Lofdahl, 85% of their customers for multichip modules are interested in speed and are trying to build systems having clock rates from 40 megahertz to a gigahertz or more. The other portion consists mainly of military equipment makers interested in ultrahigh density.

Raychem, which only began multichip module production in July 1987, is one of the first independent companies to produce multichip modules for customers under contract; virtually all prior multichip module work has been by captive makers such as AT&T, Digital Equipment Corp. and IBM.



Experts say multichip modules are the closest thing to having the entire system condensed onto a single silicon wafer

Raychem fabricates a 5-inch-diameter, circular substrate which can be cut to produce modules of various sizes, accomodating from two to 50 individual chips. Actually, the number of chips interconnected on a multichip module depends on "the courage of the customer," says Lofdahl, since traces are too small to probe, repair can become an almost impossible task on modules sporting many ICs.

So far, Raychem provides only unpopulated modules to customers. Customers are responsible for bonding the die to its pads, attaching a connector and testing and repairing the completed assembly.

Some customers would like to hand over the assembly process to the module maker, but this raises the issue of security, since the module can represent a major portion of the product. Lofdahl says assembling the module requires access to a customer's test vectors, comprehensive directions for testing the system, and the most zealously guarded of proprietary information. "It's like asking for their wife for the weekend," he says.

High fabrication cost is another problem of multichip modules. The design and tooling cost for a 5-inch wafer can run between $70,000 and $145,000. Production costs can range from $75 each for low-complexity 1-inch-square modules to between $1,000 and $4,000 for 9-inch-square modules, with price varying according to complexity.

With prices like this, multichip modules are not for everybody. "We're a rifle-shot package concept," admits Lofdahl. "But," he adds, "the customers that need us, need us badly."

New IC packages

For equipment makers who cannot afford to deal with multichip modules, some good news: IC makers, equipment makers and packaging houses are helping with the interconnect problem by supporting a range of new packages to replace the bulky, old dual in-line package (DIP) that has endured in the industry since the 1960s. In fact, the new packages will continue eroding the DIP's 82% share of the 43 billion unit IC package market to 51% in 1992, according to Integrated Circuit Engineering, a Scottsdale, Ariz., market researcher.

These new packages are smaller, lighter and feature up to several hundred pins to meet the high input/output (I/O) requirements of such chips as application-specific ICs. They boast electrical characteristics superior to those of DIPs and possess a greater ability to dissipate the watts of heat that such chips generate. Lead-spacing can be as tight as one-quarter that of the DIP (.025-inch versus .100-inch). Surface-mounted "J" or "gull-wing" leads are gaining popularity at the expense of conventional through-hole pins.

Despite the boggling assortment of new packages, experts report some consensus is developing around sev-

eral newly popular packages.

The biggest trend in packaging, according to experts, is the wholesale move by the industry to packaging high-volume commodity ICs in small outline ICs (SOICs). "This is by far, the highest growth package in the world," says Daniel Rose of Rose Associates, a Palo Alto, Calif., packaging consultant. In the United States alone, says Rose, SOIC usage grew from a monthly volume of 10 million at the beginning of 1987 to 100 million by December 1987. The reason, says Rose: "All the little transistor-transistor logic circuits that used to be packaged in 14-lead DIPs are being packaged in 14-lead SOICs."

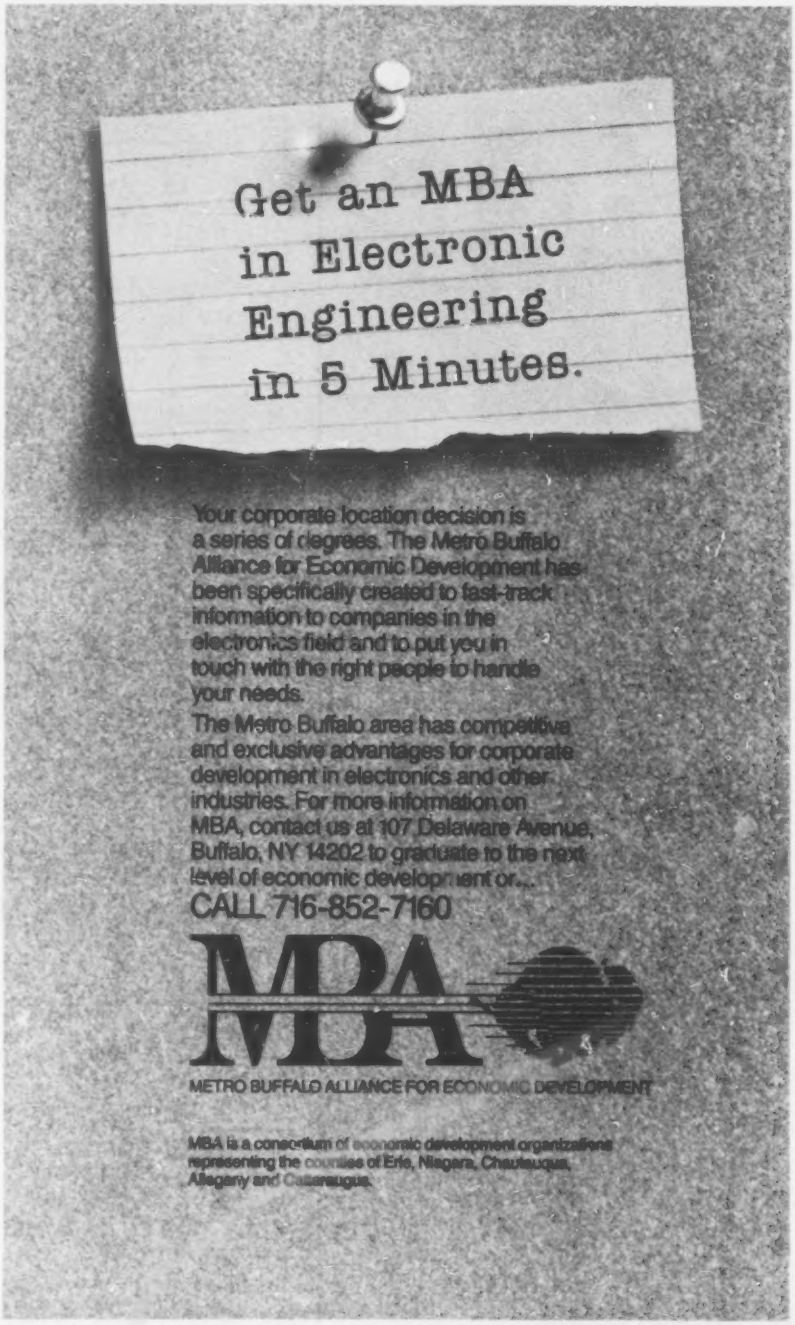
The SOIC provides a 60% space savings over the DIP, and weighs less, points out Dean Winkleman, a researcher with Integrated Circuit Engineering (ICE). Consequently, the SOIC has become the package of choice for surface mounting "jellybean" ICs having eight to 20 pins, such as dynamic random access memories (DRAMs), logic circuits, and linear ICs. Winkleman says that SOICs currently hold 6% of the worldwide IC marketplace, up from practically zero in 1980. The growth derives mainly from applications in the United States and Japan. Winkleman says the growth march of the SOIC has only begun: he anticipates SOICs will capture 25% of the market in 1992.

Look for the zigzag in-line package (ZIP) to continue gaining popularity for packaging DRAMs, as users that are staying with through-hole mount technology choose it as a high-density alternative to DIPs. "You can actually achieve superior density over the SOIC if you have the vertical clearance," says Winkleman. He sees ZIPs garnering 20% of the worldwide memory market by 1992, with SOICs and DIPs each taking 40%. Today, the ZIP's share of the memory market is "less than 5%," says Winkleman.

The plastic quad flat package (PQFP), employing small, molded bumpers on each of its four corners, will also see healthy growth for ASICs and standard very large-scale integrated chips. The bumpers protect its 40 to 244, .025-inch-spaced gull-wing leads from becoming tweaked during handling. And many in the industry see the package as the lower profile, higher density version of the plastic leaded chip carrier (PLCC). Winkleman estimates that the .050-inch lead-spaced PLCC will hold steady at roughly 3% of total IC package usage, while the PQFP will leap from 1% currently to 5% by 1992.

Pin grid arrays (PGAs) will remain the preserve of high-I/O chips, 100 pins and up, and high-power VLSI circuits that need the heat-dissipating capabilities of ceramic. ICE estimates that PGAs will grow from slightly under 1% of the market today to 2% by 1992.

Other package developments to watch: leaded ceramic chip carriers, whose leads absorb the thermal expansion that causes cracking on leadless ceramic chip carriers. ICE expects these to grow to 1% of IC units by 1992; also, premolded plastic packages utilizing a corrosion resistant silicon gel, as a less expensive replacement for hermetic ceramic packages. The Institute of Electrical and Electronics Engineers is now evaluating gels and military qualification could start later this year. □



SEMICONDUCTOR PRODUCTION

VLSI lithography: Thin lines, thinner profits

Making the hardware that writes circuit patterns on wafers is becoming increasingly costly and complex

By Carol Suby

Microlithography — the process by which integrated circuitry is patterned onto semiconductor wafers — presents myriad challenges for the makers of the equipment that aligns the circuit pattern masks with the wafers. Leading-edge VLSI chips, such as 4-megabit dynamic RAMs, are packed so densely that they call for design rules — the smallest element of a transistor that can be fabricated — smaller than a micron. In addition, these chips require 10 or more patterns to be drawn atop one another with overlay accuracies of 0.3 micron or better. This task is comparable to placing a human hair on a football field with an accuracy that is the equivalent of getting a hole-in-one from an 18-mile drive.

Creating a piece of such precision hardware can cost tens of millions of dollars and typically requires a two-year development time. Once that is achieved, vendors are faced with a myriad of external issues. Masks or reticles — master images of circuitry used in the process — must be up to snuff to handle the ever-shrinking linewidths. And special resists — the photosensitive chemicals used to coat the wafers and receive the masks' images — are also required to handle submicron technology.

THE TECHNOLOGY

Beyond equipment and material issues, competition is fierce, profits run from thin to nonexistent, and the equipment manufacturers are buffeted by the cyclical market for semiconductors.

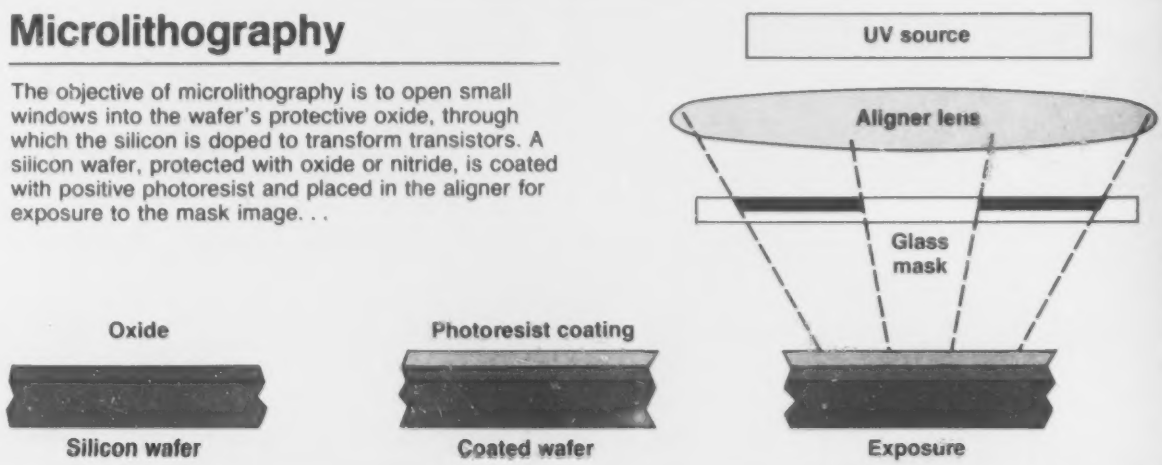
The number of transistors integrated into a chip has moved to the very large-scale integration level. Feature sizes are moving toward smaller than 1 micron (a millionth of a meter). In addition, VSLI chips must be made by successive alignment and fabrication of 10 or more patterns for the circuit elements and their interconnections. Consequently, microlithography, the process of laying down the images for those elements, has become increasingly complex.

There are two basic categories of equipment used to perform this task: alignment systems and direct-write systems. Within the alignment category, optical or photolithography equipment is most commonly used today. This process works very much like making prints from camera film, whereby a lens focuses light through a negative, exposing and transferring an image to a photosensitive coating on the print paper.

In VLSI photolithography, a computer-generated circuit pattern is first

Microlithography

The objective of microlithography is to open small windows into the wafer's protective oxide, through which the silicon is doped to transform transistors. A silicon wafer, protected with oxide or nitride, is coated with positive photoresist and placed in the aligner for exposure to the mask image. . .



produced on a master image — a reticle or mask. Its quality and the image definition are critical, because any blemishes or imperfections will be transferred from the mask to the wafer. For VLSI masks, images are drawn on a glass plate by an E-beam.

This master image is positioned over a silicon wafer that has been coated with photoresist, a photosensitive diazo chemical. Then, light or ultraviolet rays pass through the clear areas of the mask and expose the photoresist on the wafer, forming a latent image. Whenever possible, the image for the whole wafer is transferred in one step. The more critical alignments and finer circuit features, however, must by transferred in successive steps by a stepper aligner that indexes the mask over the wafer, imaging a few circuit cells at a time. The resist areas so exposed polymerize and harden, whereas the rest of the resist can be easily removed chemically or with plasma. This permits selective doping of the wafer, by diffusion or ion implantation, to build the desired circuit properties into the silicon.

Only a few years ago, a design rule of 1 micron was considered the limit for optical lithography. Today, however, the combination of lenses that are efficient in the ultraviolet range down to 0.365 micron (called i-line), and high-purity photoresists, has allowed manufacturers of stepper aligners to push beyond that barrier. "It sounds unbelievable. They are pushing the limits of light optics," says Dr. Hans Friedrich, head of the "Megaproject" at Siemens AG. This project, partially funded by the West German government, has a goal: catching up with Japan in 4Mb DRAMs.

"Our design rules for the 4Mb DRAMs are, conservatively, 0.7 micron," says Friedrich, "but we can go to 0.6 using optical lithography." He thinks even 16Mb DRAMs can be built with 0.5 micron rules. Beyond that, however, photolithography hits the physical barriers imposed by the diffraction of light as it passes through the small openings of VLSI masks. To draw finer lines, lithography needs beams narrower than UV sources can provide. Companies worldwide, some with their governments' help, have invested heavily in lithography using the next-narrower source of radiation: X-rays. Another approach altogether eliminates the masks; it consists of writing the IC patterns directly onto the wafers.

Today, X-ray lithography equipment remains in the experimental stages of development and is expected to continue there for some time because many factors remain to be solved with this technology. Current commercial resists do not work well with X-ray because their variations in thickness are often greater than the linewidths the X-ray is drawing. An even bigger problem is developing a mask or reticles that remain stable under a barrage of X-rays.

Direct-exposure systems, which write IC patterns directly on the wafer, also remain primarily in an experimental stage. This category includes three major product types — electron- or E-beam, focused ion-beam and laser direct-write equipment. E-beam systems are the only ones to reach commercial use; primarily for prototyping and for small lots, up to 10,000 ICs.

E-beam systems have become the standard equipment for making photolithographic masks. However, an emerging technology — laser scanning — is inching its way into mask making.

THE MARKET

Within the microlithography and mask making market, wafer exposure equipment has the lion's share of revenue. Last year, worldwide sales of wafer exposure equipment totaled $697 million, or 75% of the total $934 million market. That share is expected to hold into the future, according to research firm VLSI Research Inc., in San Jose. But the market is not large enough "to support all of the competition," says Aubrey "Bill" Tobey, president of consulting firm ACT International Inc., in Burlington, Mass.

During the recent downturn, the roster of microlithography equipment vendors began to shrink. Some of the heavy hitter dropouts include: Eaton Corp., which exited the wafer stepper arena; and Varian Associates Inc., which folded its direct-write E-beam operations.

Those remaining in the game are pushing to keep abreast with leading-edge technology. "All equipment people are struggling like hell to get to submicron technology. But the fact is, the manufacturers are at 1 micron," says Richard Ruddell, president of consulting firm Ruddell & Associates Inc., in Redding, Calif. People are "stalling" at 1 micron, he adds. In fact, according to estimates by VLSI Research, of the 3.5 billion ICs produced in 1990, 1.4 billion, or 40% of them, will be in the 1.6-micron to 3.0-micron range. Only 316 million, or 9%, will fall into the 1.5-micron and below category.

Consequently, some companies claim that over the next several years most battles in this marketplace will be fought along nontechnological lines. Many customers agree. At AMD Inc., the greatest concern regarding production equipment is its productivity, says William Arnold, manager of VLSI lithography development at the company's headquarters in Sunnyvale, Calif. And low productivity has been the biggest disappointment regarding wafer steppers, he adds. Currently, Arnold would like to double the net wafers per hour that he's getting.

Other concerns that Arnold points

. . . after resist development and removal, the oxide is etched to open a window. "Design rule" is the smallest window that can be opened. Projection mask aligners expose the whole wafer at once. Aligner steppers, which are used to resolve finer features, image only a few cells at a time and must repeat the pattern by stepping across the wafer. The larger the aligner lens' reduction, the finer the features it can resolve, but the longer it takes to step across the wafer.

Etched resist Etched oxide

to — set up times, yields, calibration or machine stability, the ability to make adjustments "on the fly" — are the very platforms upon which competitors are trying to separate themselves.

Indeed, today's customer wants a great deal more than fine-line resolution, says Peter Simone, president and chief operating officer at GCA Corp., in Andover, Mass. Custom and semi-custom houses, which might run only 20 to 100 wafers per work order, are taking the lead in demanding better overall performance in the lithography equipment they buy, Simone adds. "There's more focus on equipment utilization, higher throughputs on smaller lots and demand that equipment be as close to self calibrating as possible," he says.

While both sides of the vendor/customer fence repeat the same litany, both also admit that, at least in the United States, their relationships have a long way to go toward improvement. "A fundamental problem is that there's no real honest communication between device manufacturers and equipment manufacturers," says Ruddell.

In fact, time and again, manufacturers have built equipment according to customer demands only to find that when the product was ready for market, the customers — for a variety of reasons — were no longer interested. In defense of the customer, AMD's Arnold points out that, while it's tough to predict what will be needed three or more years out, the rapid changes in equipment offerings are also frustrating for buyers. In wafer steppers alone, with seven different competitors averaging 18-month cycle times for product introductions, Arnold says, about every three months buyers are faced with yet another product announcement. "But you have to learn how to live with that," he sums up.

In addition to keeping a close eye on developments in wafer steppers, chip makers must also keep abreast of two other technologies in the wafer exposure equipment market: X-ray lithography and E-beam. VLSI Research expects that by 1991, worldwide sales of X-ray lithography systems will total $52 million, or 4% of the total wafer exposure equipment market. For E-beam wafer exposure equipment, the forecast is $205 million, or 15% of that market in 1991.

Within the industry, bets on X-ray technology are split down the middle. Some observers believe X-ray will take over once optical systems can no longer do the job. Others say X-ray has missed its window of opportunity and will never become commercially viable.

AMD's WILLIAM ARNOLD: The greatest concern regarding production equipment is its productivity

Many X-ray nay-sayers are betting that direct-exposure systems will replace optical-based systems. Most direct-exposure systems today are still experimental. Of three approaches in contention — using either electron beams, ion beams or lasers — E-beam systems are the most commercially successful.

During the recent downturn, the roster of microlithography equipment vendors began to shrink

THE COMPETITION

If history repeats itself, Nikon — the current leader in worldwide unit shipments of wafer steppers — could be in for an upset. Since the 1960s, when Kulicke & Soffa Industries Inc.'s contact aligner became the industry standard for lithography, "no company has ever dominated the lithography market for more than five years," says G. Daniel Hutcheson, of VLSI Research.

Just in the past 10 years, three new leaders have emerged, and industry watchers are already placing their bets on the fourth. Optics specialist Perkin-Elmer Corp. of Norwalk, Conn., became the leader in the 1970s with its projection mask aligners. "By 1981, the game shifted from projection systems to steppers. Perkin-Elmer was on the defensive," says Hutcheson. And, GCA was the beneficiary. This company accounted for 73% of the 240 wafer stepper machines installed during 1981, according to Ruddell of Ruddell & Associates. GCA's days in the sun, however, were short-lived.

By 1985, Nikon Precision Inc. had become the clear leader in wafer steppers. This subsidiary of Japan's Nippon Kogaku KK had installed only 25 wafer steppers during 1981, compared to GCA's 175 installed that same year. Four years later, the tally was Nikon: 145, and GCA: 115, according to Ruddell.

A winning factor was that Nikon's was "a production worthy system," suggests Gil Varnell, senior vice president of technology and R&D for Nikon's U.S. headquarters in San Bruno, Calif. It was also "the first to offer guaranteed uptime specs," and strove to beat the competition in service, Varnell adds.

"Some mistakes were made," concurs Simone of GCA. "We had to do more work on application support — helping a customer apply the system to his process. . . . We also had to address performance issues, and we were late in getting a solid 1-micron machine to market." Today, GCA is struggling to turn its fortunes around. The management has been revamped and, according to several industry analysts, the company has righted its equipment shortcomings. Also, a $20 million financing deal, inked at the end of 1987, will allow the company to ramp up production to meet backlog demands, which totaled $41 million at the end of last year's third quarter.

Meanwile, Nikon has little time to rest on its laurels. Nikon's dependable equipment and fastidious attention to support might have put them on the top of the heap, but it won't necessarily keep them there, according to consultant Tobey of ACT International. "When you have competition, you have to step on their throats. You've got to kill them," advises the former GCA executive. "Canon has decided it's going to take the market. Nikon and Canon will get into some battles, but Canon will win. It's the bigger animal."

Others in the industry are also

looking to Canon as the next winner, but there's still room for a surprise. Although Canon might be the "best bet," for the next market leader, many other players are still in the running, suggests Hutcheson. The number of unit sales for Ultratech Stepper of Santa Clara, Calif., a unit of General Signal Corp., "has grown by almost five times in the last year. . . while Canon has roughly doubled and Nikon is up around 35%," according to Hutcheson. But, he adds, dark horse GCA "could make a comeback, and you never know what Nikon's got in R&D." Another company to watch, Hutcheson notes, is Tempe, Arizona-based ASM Lithography Inc., which is jointly owned by Netherlands companies N.V. Philips and Advanced Semiconductor Materials Inc. According to Ruddell, ASM currently makes "the best stepper [that] will do submicron technology." Both Philips and Siemens use ASM's steppers in their efforts to catch up with the Japanese in RAMs.

Because X-ray is still in its infancy, competition is limited. Hampshire Instruments Inc., based in Marlborough, Mass., is currently the only surviving start-up in X-ray lithography. Other companies that are continuing research in this field include IBM, Karl Suss KG GmbH & Co., based in West Germany, Nikon and Perkin-Elmer.

The field of competition is a bit more crowded in the more mature direct-write E-beam arena. For use in mask or reticle making, Perkin-Elmer's MEBES systems account for 82% of the 1986 market worldwide. In direct wafer exposure, Japan's JEOL Ltd. dominates with 45% of the 1986 market, according to VLSI Research. Other competitors include ASM International, Cambridge Instruments Inc., Hitachi Ltd. and Perkin-Elmer.

COST OF ENTRY

If staying in the microlithography market is extremely difficult, entering it is next to impossible. It is not uncommon for a start-up to spend five years and $50 million to get its product to market, only to fail before shipping production volumes. The reasons for failure vary from addressing a technology too early or too late, running out of funding before project completion or coming to market during a recession.

Digital Automation Corp. (DAC), based in Burlington, Mass., is an example of one company that had considered entering this marketplace but was discouraged by the huge investment required to get a machine to market. DAC had been using computer-aided design tools to assist lithography equipment vendors in machines. Using those CAD tools, "it appeared we could design a breakthrough optical lithography machine," says Nicholas Mango, DAC president. But the company decided the costs of entering the market were prohibitive, Mango adds.

NIKON's GIL VARNELL: Dependable equipment and fastidious attention to support have put Nikon on top

Companies as well as governments continue to spend heavily in the push to make X-ray a viable technology for lithography

Others opted to forge on. In the still experimental area of X-ray lithography, an estimated $26 million was invested in Micronix Corp. before the Los Gatos, California-based company folded. Tobey of ACT International, who was also a Micronix executive, estimates that when the company was in full swing, it was spending money at a "burn rate of between $500,000 to $600,000 a month."

Meanwhile, Hampshire Instrument has one piece of equipment being used in pilot line production, according to Darryl Peters, director of applications and metrology at Hampshire. While Peters would not reveal how much funding has been poured into Hampshire, he suggests that it can cost $30 million to bring an X-ray lithography tool to the beta testing stage.

Companies as well as governments continue to spend heavily in the push to make X-ray a viable technology for lithography. "A few hundred million dollars are currently being poured into X-ray by IBM and by companies in Japan and in Germany," according to Tobey. Some of those companies include Canon, Fujitsu Ltd., Hitachi, Matsushita Electric Industrial Co., NEC Corp. and NTT in Japan; IBM in the United States; and Philips, Siemens, and Karl Suss in Europe. In Tobey's mind, there's no doubt that "X-ray is the technology that will take us beyond what photolithography can do."

In the other post-photolithography camp, however, are the believers in direct-write systems. Most of them are betting on E-Beam technology, which has also consumed a bundle but has yielded few results. Considering the estimates of VLSI's Hutcheson — development costs for a state-of-the-art E-beam machine can run in excess of $100 million — it's not surprising that there are no start-ups in this market.

Price tags for E-beam direct wafer exposure systems are in the $5 million range, and operating speeds are significantly slower than those of optical systems. The two current market applications are for low-volume ASIC devices, where savings in reticles make up for the machine price, or for prototyping devices, where fast turnaround is essential, says Stephen Reber, director of lithography for Perkin-Elmer's Connecticut operations. One example of an E-beam user is ASIC maker European Silicon Structures. According to Reber, European Silicon makes highly customized circuits; for its needs, E-beam direct wafer exposure equipment has proven to be cost effective. For high-volume users, however, cost and speed will have to improve. "If it [E-beam] weren't so slow and expensive, a lot of people would use it," says Arnold of AMD.

GCA's Simone roughly estimates that for 4Mb DRAMs on 6-inch wafers, E-beam would do well to produce three to five wafers an hour, compared with 40 to 45 for an optical system. GCA, along with Varian and Veeco Instruments Inc., invested millions of dollars in E-beam equipment

development before dropping out.

Indeed, in the world of lithography equipment manufacturing, funding is a major issue. Some, like ASM Lithography, Canon and Nikon, can be carried by multibillion dollar parents when the profits are nil. For example, Paul Henry, director for marketing at ASM Lithography, points out: "Our parent [N.V. Philips], has invested billions of dollars over the past few years to improve its position in the semiconductor industry. . . trying to get its level of expertise up to that of the Japanese and Americans. We are part of that investment."

Other companies are either at the mercy of investors or must depend upon internal resources. Because of the tremendous initial investment required — $30 million to $50 million — the risk that there might never be a return on that investment, and the amount of time it takes to actually sell equipment at production levels, it's almost impossible for any new company to break into the microlithography market.

If a company has a really excellent name or technology, then "with great difficulty" they might be able to raise the money, says John Turner, a managing partner with investment firm Techno-Venture Management in Boston. It is also possible to spend double-digit millions on product development, have good success in the marketplace, and yet not make any money. Ruddell of Ruddell Associates questions whether or not anyone in the stepper business is really making any money. He even goes so far as to predict that, "10 to 15 years from now most merchants will be gone." Unless the industry can make equipment profitably, he adds, "the IBMs, GM Delco Electronics, Rockwells etc., will have to go out and buy these companies, and count the equipment as a part of overall manufacturing costs."

THE OBSTACLES

Where does all the money go? Why is it difficult for even the market leaders to make money? "Production development time is almost as great as product life cycles. It takes about two years to bring a new product to market, and it only lasts for two to three years," says Henry at ASM. In addition, he points out, research and development costs, which average between 15% to 20% of sales, are "well above the national average in business."

There are a number of things that eat up production dollars in wafer steppers, from the optics, to mechanics, to electronics to software. The materials alone in a wafer stepper cost several hundreds of thousands of dollars, says Tobey of ACT International. For example, a laser can cost $25,000 to $50,000 and a lense can cost from $35,000 to $40,000, Tobey estimates.

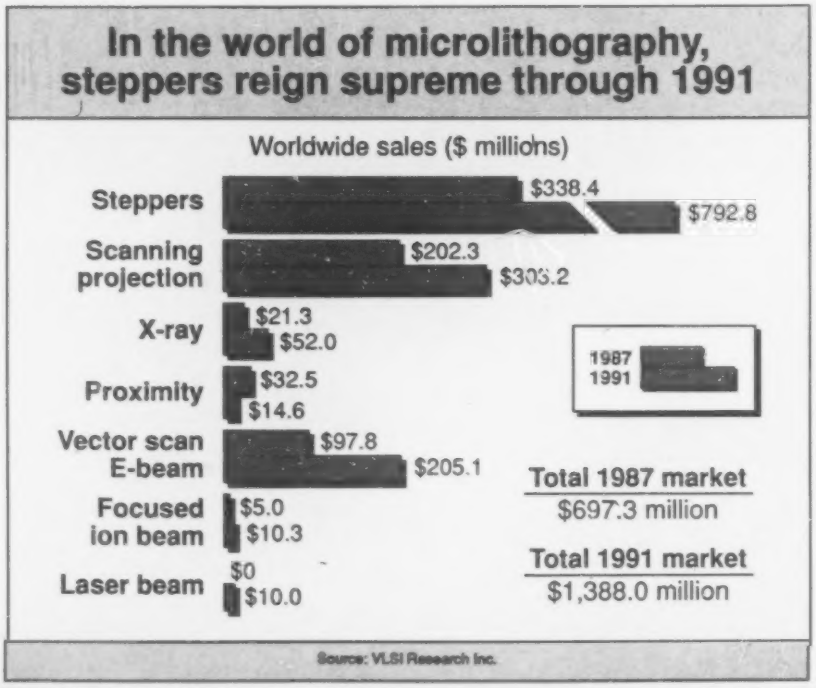
Indeed, every player must excel in not one technology, but several. To build and design a stepper, one must be at the leading edge not only in optics, but in software, vision and alignment, precision measurement and precision mechanics, details Simone of GCA. And then, once a system is built and gains market acceptance, "support costs are substantial," Simone adds. Vendors must offer service around the clock. They must also provide a great deal of application support. And, because this is a globalized market, he adds, "you have to participate in 22 countries and must be indigenous in every country."

The history of now-defunct Micronix illustrates the difficulties of a lithography start-up. During its years of operation, from 1981 to 1987, the company spent in excess of $26 million, estimates Tobey, who is also a former Micronix executive.

After shipping its first three systems to customers in Japan for use in R&D, Micronix realized changes had to be made before it could interest U.S. customers, who wanted a production machine. Also, unexpectedly, developments in conventional optical steppers pushed the need for X-ray further out. And, as with any company working in X-ray microlithography, there were additional issues to be resolved. Besides the actual system, the company had to develop special X-ray masks and a better alignment system than what was used with conventional steppers. Also, a faster resist specifically built for X-ray sourced lithography was needed.

By 1986, the dollar was falling and orders expected from Japan dried up. A lot more money and a few more years were needed to get the product to the point at which it could be useful in production, says Tobey. By the first quarter of 1987, Micronix was looking for more dollars either through increased orders or equity investments or a corporate partner. In the third quarter of 1987, the company ceased operations. "We had an excellent team of people. The hardware was done," notes Tobey. "But when the dollar declined and the potential sales dried up in Japan, our schedule of need did not fit the availability of dollars." He goes on to say that, "there is no small, privately funded company that can possibly do it all." What's needed, he says, "is *an equity partner, someone with deep* pockets." □

In the world of microlithography, steppers reign supreme through 1991



Source: VLSI Research Inc.

TAPE DRIVES

Why tape makers love to hear those hard disks crash

Quarter-inch tape drives are clear favorites for the data backup that is fast becoming essential for small computers

By Brian Deagon

The outlook for manufacturers of tape drives that use quarter-inch data cartridges is getting rosier all the time. After years of trying, they are finally getting the business they've long sought from major computer companies.

"We have been looking at other technologies, but quarter-inch tape makes the most sense for now," says Marti Hayes, tape drive product manager for Prime Computer Inc. "They make the most sense from the viewpoint of size and cost." Prime integrates 60-megabyte tape drives into its three desktop multiuser computer systems.

And 3Com Corp., which began using quarter-inch tape drives in its local-area network systems three years ago, plans to continue doing so, says Charles Leis, server manager engineer. He notes that integrating the drives is much easier now than when they started. "We had major problems getting them running at first," he says. One problem was a lack of software development, an issue that has since been resolved.

Although half-inch reel-to-reel tape drives have been used as data storage devices for more than 25 years on mainframe computers, the use of the smaller quarter-inch tape drives only blossomed after it became clear that microcomputers needed a more powerful backup device than floppy diskettes.

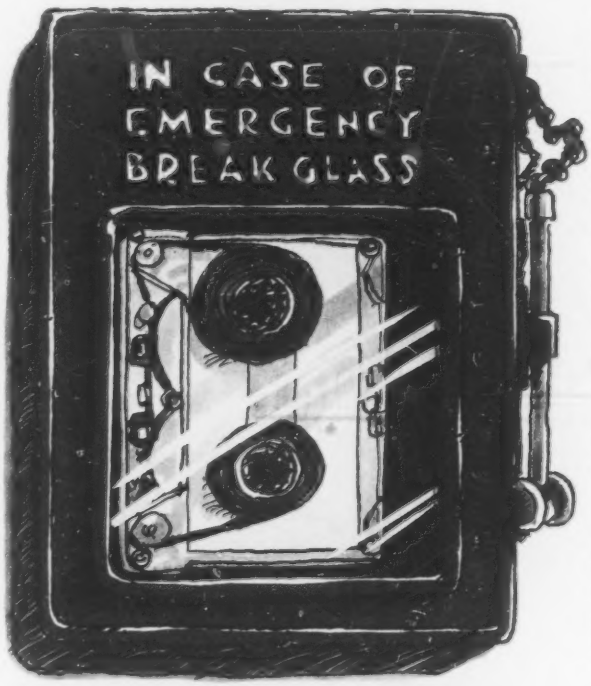
Despite the introduction of quarter-inch tape technology by 3M Co. in 1971, product acceptance was next to nil because the tape drive manufacturers failed to respond quickly enough to key issues, such as the need for smaller, faster, cheaper, compatible and more reliable products. This failure to respond gave OEMs and system integrators the jitters.

Much of that has changed, however. Computer makers will integrate more quarter-inch tape drives into microcomputers and minicomputers this year than ever before, analysts say. The list of manufacturers increasing their commitment to quarter-inch tape includes AT&T, Compaq Computer Corp., Honeywell Inc., Prime Computer Inc. and Unisys Corp.

In addition, IBM has been evaluating quarter-inch tape drives for several months for use in its Personal System/2 product family, and is expected to introduce new products sometime this year, industry sources acknowledge.

Indeed, 1987 is cited as a watershed year for the quarter-inch tape drive industry. It was the first year that shipments exceeded 1 million drives, according to Freeman Associates Inc., a Santa Barbara, California-based market research firm which closely monitors the tape drive industry. During calendar 1992, more than 2.3 million units will have been shipped worldwide. By comparison, less than 30,000 drives were shipped in 1982.

Annual worldwide revenue is expected to increase to $759 million in 1992, from $496 million in 1986, Freeman projects. "The quarter-



In case of disk crash, don't call floppies. Tape is becoming the emergency back-up of choice for PCs with over 40MB on disk

Jon McIntosh

inch tape drive industry feels secure as a major growth industry for the rest of this decade," says Freeman Associates president Raymond Freeman Jr.

Previously, the industry outlook was not so good. In the early 1980s, the people who might use tape backup viewed the product as another form of insurance, but nothing mandatory.

What spurred the industry on was the growing use of hard disk drives in microcomputers and multiuser systems. The disk drives got smaller while the amount of data they could store grew higher. A bevy of microcomputers and multiuser systems is now now shipped with 40MB and 60MB hard disk drives and higher, all of which fit the 5.25-inch form factor.

At disk drive capacities above 20MB, using floppy diskettes as a backup device is about as practical as a four-cylinder engine in a race car. The demand for an inexpensive backup device is shooting up and low-end tape drives are best positioned to capture the greatest market share, analysts say. "The demand for quarter-inch tape drives coming from our computer system vendors and third party distributors is well ahead of last year," says Steve Malisewski, marketing vice president for Microage Computer Stores Inc., an international value-added dealer. He says the increase in demand is related to the fact that today's microcomputers are far more powerful than those being offered just three years ago.

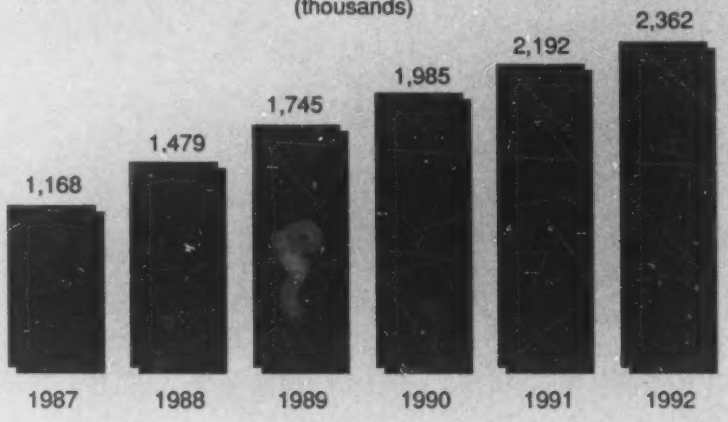
The increased demand for tape drives came only after unprecedented cooperation between the competing tape drive manufacturers, however. Tape drive companies were a scattered lot until 1982, when they united under the banner known as Quarter-Inch Compatibility Working Group. QIC outlined a set of standards designed to insure that the drives would record and transmit data in a manner that was compatible from one manufacturer's tape drive to the next.

The plan apparently worked. Tape drive shipments doubled in 1984 and more than doubled in 1985. Currently, more than 30 low-end tape drive manufacturers offer more than 100 classifications of tape drives, says Freeman. More than half of those companies are based in the United States.

The industry joined hands again in 1986 and embarked on a nationwide educational and advertising campaign designed to drive home the idea that quarter-inch tape should be used to back up data on microcomputers and LANs. "We invested lots of dollars to tell everyone who had a PC with a 20MB disk drive or higher that they need to secure their data with a backup device," says Charles Calisto, 3M Co. marketing manager for data cartridge products. Citing research, Calisto says that filling a 20MB hard disk drive takes about one month and can cost upward of $50,000 to replace if that information is somehow deleted or lost due to disk crash or user error.

Tape drive companies also cooperated on a direct mail campaign that delivered 4,500 promotional packages to management information systems directors, data-processing managers and the like. Almost 20% responded for more information, says Calisto.

1987 was the first year quarter-inch tape drive shipments exceeded 1 million units



Source: Freeman Associates Inc.

Tape drive shipments doubled in 1984 and more than doubled in 1985

The need for a unified tape community is spurred partly by the encroachment of other manufacturers touting newer technologies to replace quarter-inch tape as a standard backup device. The designers of computer storage devices have long recognized that desktop publishing systems, PC workstations and CAD/CAM systems and other powerful 80386-based microcomputers are digesting huge amounts of data. As a result, "backup is no longer an option — it's a necessity," says Norm Weinberg, director for marketing and distributor sales at Wangtek Inc., a tape drive manufacturer.

Tree rattling

"At capacities of 20MB and below, you can still use a floppy to store data. But when you go beyond 40MB, a user can't afford to lose that data," says Weinberg. The quarter-inch tape drive industry had its tree rattled last April when IBM introduced a write-once, read-many times (WORM) optical disk for use as a data storage and retrieval device. But optical WORM drives are receiving only lukewarm reception for now because no one has introduced erasable optical media — a crucial step if the product is to be taken seriously, many analysts agree.

Another technology waiting in the wings is digital audio tape, which uses a helical scan recording head that is able to record data on tape at densities well above current quarter-inch tape technology. Digital DAT drives could compete with quarter-inch tape and become an industry standard for data storage in the 1990s if interface and format standards are resolved, says Lee Elizer, president of Peripheral Strategies Inc., a Santa Barbara-based market research company.

Only one manufacturer — Exabyte Corp. — is currently shipping low-end helical scan tape drive products for data storage. But Hewlett-Packard Co. and Sony Corp., among several other well-heeled companies, are

studying DAT technology. Where those efforts will end up, it is too soon to tell. Still, Exabyte announced more than $25 million in sales to OEMs, VARs and system integrators in its first year.

Another threat to quarter-ineh tape comes from developers of low-end tape drives that use the half-inch tape cartridges endorsed by IBM, called the 3480. But this, like the other competing technologies, is still in fledgling stages of development and is not endorsed by major manufacturers to the degree that quarter-inch tape has been.

A further challenge to quarter-inch tape technology is posed by makers of low-cost tape drives that use audio-sized cassettes to store data. This group of manufacturers, which includes TEAC Corp. and Eastman-Kodak Co. subsidiary Verbatim Co., has also banded together to standardize its products. But they have been slow to promote their products aggressively and may soon find themselves trailing in the tape drive sweepstakes if more action isn't taken soon, analysts note.

In the meantime, the quarter-inch tape drive industry is taking every step possible to cover its flanks. For instance, QIC recently incorporated as a trade association, which means it will be able to elect a staff of people to conduct more aggressive marketing, do cooperative advertising, offer more seminars and distribute literature to promote quarter-inch tape technology.

Another sign of the industry's maturation was its quick redesign of tape drives to fit the emerging 3.5-inch industry standard form factor. In 1987, Freeman forecasts that the tape drive industry will have shipped 492,000 tape drives that can fit the 3.5-inch form factor, compared to none in this class less than four years ago.

Boost from Apple

The outlook for these tiny quarter-inch tape drives was given a major boost last year when Apple Computer Inc. announced it would support the product on its new line of Macintosh II and SE microcomputers. This class of drives will exceed 1.5 million units shipped in 1992, a 36% annual growth rate from the 250,000 units shipped in 1986, says Freeman.

Tape drive manufacturers have demonstrated an ability to shrink the product while they increase data storage capacities — key issues if they are to remain the storage device of choice at the low end. Products now being shipped range up to 125MB and 150MB capacities. But three Southern California-based companies — Archive Corp.; Siemens AG subsidiary Tandberg Data Inc.; and Wangtek — say that this year they will ship quarter-inch tape drives which store 320MB. It does not stop there: 3M recently announced plans to ship a 1-gigabyte quarter-inch tape drive by late 1989.

The California trio comprises, along with Cipher Data Products Inc., the leading tape drive manufacturers. Two other companies also cited for tape drive development are Alloy Computer Products Inc. and Irwin Magnetic Systems Inc. Their collective push into products that store hundreds of megabytes appears to be what OEM customers want: "We're anxious for higher capacity tape drives," says 3Com's Leis.

"There is a much greater appreciation for tape backup today than there was a year ago," says Frank Kirchoff, director of computer distribution for Microlynx Inc., a Torrance, California-based distributor of PCs and peripherals. "We consider tape backup to be a commodity product now. Pricing has gotten very competitive and portability and compatibility issues have been resolved," he notes.

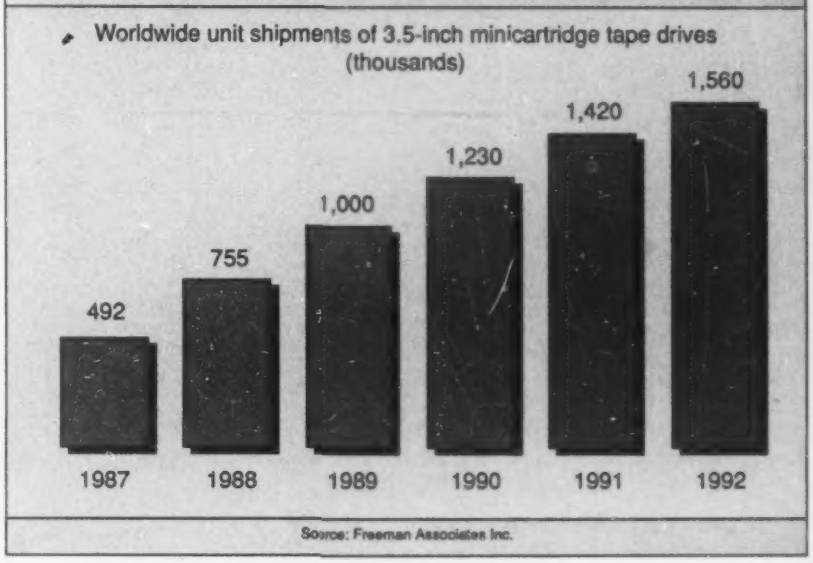
Microlynx sells a 60MB, quarter-inch drive made by Cipher Data for a list price of $990. About two years ago, that same drive cost about $1,500. The increased demand for products has allowed manufacturers to achieve greater efficiencies in manufacturing, thus lowering costs.

Computer retailers are enthusiastic too. "The time has come for quarter-inch tape drives," says Dennis Kemmerer, product research analyst for computer retail chain Businessland Inc. "People are less willing to back up data on floppies due to the amount of time it takes," he adds. Businessland has been studying other data backup devices, including optical disk drives and digital audio tape. But, says Kemmerer, "what has inspired us toward quarter-inch tape drives is the increased functionality of software and the network compatibility."

Most leading computer retail chains and distributors now carry quarter-inch tape drives in their inventory, notes Whitney Lynn, chief operating officer of Tecmar Inc., which markets quarter-inch tape drives mostly through third-party channels. He says companies that now use quarter-inch tape as a standard backup device routinely include Atlantic Richfield Co. (ARCO), General Dynamics Corp., GTE Corp., Mobil Oil Corp. and Universal Studios. About 15% of all microcomputers with a hard disk drive above 20MB are equipped with a quarter-inch tape drive, analysts say. Less than two years ago, about 5% of users had a quarter-inch tape drive.

Tape drive makers view this acceptance as a critical step if quarter-inch tape is to compete with and surpass other backup technologies on the horizon. □

The 3.5-inch tape drive market did not even exist less than four years ago



Source: Freeman Associates Inc.

COMPUTERS

Will Honeywell Bull survive its inheritance?

The multinational computer maker is cutting capacity and reducing staff as it searches for a valuable niche

By Steve Gross

Honeywell Bull is cutting back on people and production a year after its birth.

Formed in March 1987 by Honeywell Inc. of Minneapolis, Groupe Bull of France and NEC Corp. of Japan, Honeywell Bull consists mainly of what were once the operations of Honeywell Information Systems.

That division, however, never found a substantial niche in the U.S. computer market, and analysts say that if Honeywell Bull is to survive, it must find one fairly soon. The latest changes, analysts add, are a step in the right direction.

Paring the payroll

Last November, Minneapolis-based Honeywell Bull announced a major cutback in the U.S. operations it inherited from Honeywell. It disclosed plans to trim 1,600 U.S. workers from the 20,500 worldwide employee payroll; close a large computer factory in Phoenix; and consolidate manufacturing operations in Lawrence, Mass., all over a 12-month period beginning that November. A consolidation of company offices in Billerica, Mass., was slated to occur over an 18-month period, also from November.

The workforce reductions will include about 800 people in the firm's 3,100-employee Phoenix operations, where large computer development and other nonmanufacturing operations will remain; 500 in the 4,700-employee Boston area operations; and 300 others in sales offices across the country.

That means that about 1,000 jobs will be eliminated in manufacturing and related support services, and that 600 will be cut in marketing, sales, service and other areas, the company says. But, at the same time, Honeywell Bull has plans to add about 250 people in software development, field sales and field technical support.

Mike Habermann

HONEYWELL BULL's MEYER says the company will cut 1,600 jobs to reduce administrative costs and unneeded production capacity

The cuts are twice the size of the 800-employee reduction that Honeywell made in its computer business in 1986, a few months before spinning it off as a joint venture. Honeywell Bull president Jerome Meyer says the layoffs are designed to solidify the company's 3% share of the worldwide minicomputer and mainframe market by reducing U.S. administrative costs and eliminating unneeded production capacity. The changes won't affect the company's international operations, Meyer says, because those divisions don't have excess employment or factory capacity.

Another change at Honeywell Bull involves giving its U.S. regional sales vice presidents more responsibility to improve performance, Meyer says. That part of the reorganization "is geared to get people closer to the customer," by putting more profit-and-loss responsibility in the field, he adds.

Donald Bellomy, an analyst at International Data Corp. in Framingham, Mass., says the changes in marketing and sales responsibility are, in effect, a shake-up. "When you move profit-and-loss responsibility closer to the people who are making sales, you often make them more nervous and more motivated," he says.

The reductions in employment and factory space, Bellomy adds, reflect the longtime inability of the computer operations, under their old Honeywell management, to build market share in the United States. Unlike the other BUNCH companies, including Control Data Corp. and the Burroughs and Sperry corporations, now Unisys Corp., Honeywell never developed a strong niche for its computer business, he says. As a result, he estimates that Honeywell Bull's share of the market in minicomputers, superminicomputers and mainframes totals only about 2.5%.

"I think Honeywell Bull is still looking for a niche. They want to exploit what had been a growing strength toward systems int: gration. The difficulty that they would have at this point is that the real expertise in integration at Honeywell Information Systems was in the federal systems operation which Honeywell kept," Bellomy says.

But Honeywell Bull's Meyer says the changes were announced at a time when the computer maker was doing well. While he declined to provide earnings figures for the privately owned firm, Meyer says Honeywell Bull will be marginally profitable on revenue of $2.1 billion in fiscal year 1987. Revenue was up about 10% in 1987 in relation to comparable operations of the three parent companies

in 1986, he says.

Meyer says the U.S. market accounts for about half the revenue of the company, in which Honeywell and Bull each own 42.5% and NEC owns 15%. International operations include about $500 million worth of business in Italy; $250 million in Britain; $100 million each in Canada and Australia; and about $50 million in Mexico and the Far East, he says.

Cutting capacity

Ulric Weil, a Washington, D.C.-based analyst with his own firm, says the former Honeywell computer operations "clearly were overstaffed. This goes back years, and Honeywell has never been willing to bite the bullet. Once they were willing to sell [the computer business] off, they let someone else do that unpleasant chore."

A Honeywell spokeswoman declined to comment on Weil's assertion. But Meyer, who was head of Honeywell Information Systems, defends Honeywell and says the company would have dealt with the problems of too many employees and factories had it not been for the more immediate job of creating Honeywell Bull. "Honeywell was prepared, I think, to take action," he says. "But I think the formation of the new company and getting it started caused the situation to be slowed down."

Meyer maintains that the overstaffing situation is partly based on the technological changes that have occured in computer manufacturing since most of the former Honeywell computer plants were established in 1975.

"Technology has allowed you to produce an awful lot of power with a lot fewer manufacturing facilities," Meyer says, but Honeywell hadn't reduced its computer factory capacity significantly since 1975.

The company's U.S. computer factories have been about 50% underutilized, according to Meyer, and the reductions will cut that to about 20%, allowing room for growth. If more manufacturing capacity is needed in the future, Honeywell Bull can get it from its British plant or from Bull and NEC factories abroad, he says.

On the heels of the announcement, Frank Allen, an analyst with Arthur D. Little in Cambridge, Mass., says the changes at Honeywell Bull reflect a shift in emphasis from manufacturing to sales. In the long run, he predicts, Honeywell Bull will delegate more of its manufacturing to NEC.

Meyer disputes that. He says there isn't any plan to shift manufacturing to Bull or to NEC. For one thing, Meyer observes, the weak U.S. dollar doesn't favor moving manufacturing out of the United States.

IDC's Bellomy agrees. In addition to the unfavorable yen-dollar relationship, says Bellomy, the company might lose some potential U.S. government sales if it sold more Japanese-made machines. "Honeywell Bull is very aware of the difficulties that this can create in today's environment," Bellomy adds. One way around that, he suggests, would be for Honeywell Bull to produce future high-end mainframes in the United States under license from NEC.

But NEC probably isn't all that interested in playing a larger role in Honeywell Bull, Bellomy says. "What Honeywell Bull gives NEC is distribution, and therefore economies of scale for its high-end mainframes. Essentially the 15% [ownership of Honeywell Bull] NEC came in at is enough to make sure they continue to have a distribution channel, but not enough for them to have to worry about getting involved in day-to-day or month-to-month decisions about what's going on."

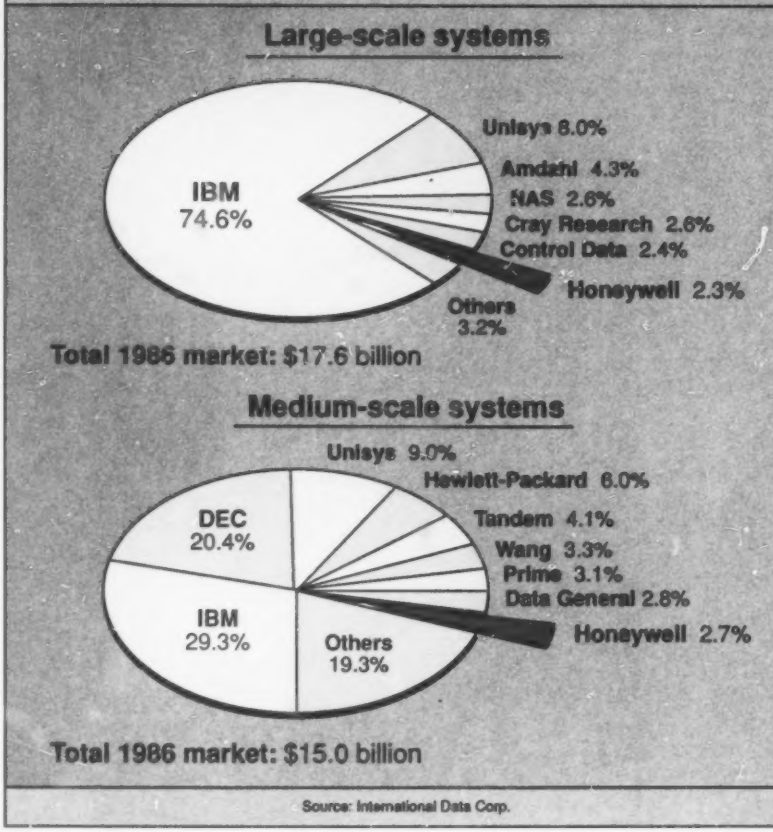
But whether or not it has to look to its parent firms for help, Bellomy says he believes Honeywell Bull has a three-year window in which it can try to find a niche in the U.S. computer market.

If the changes that have been made in U.S. operations don't provide a turnaround by then, "Honeywell Bull and Bull will become a European-based company working out of Paris," Bellomy predicts. If such an arrangement became necessary, Honeywell Bull probably would become a minor U.S. marketing organization for its European parent, he concludes.

But Honeywell Bull does have two big advantages that didn't exist when the computer operations were being run by Honeywell, Bellomy says. Honeywell Bull is exclusively focused on the computer business, while Honeywell was more diversified, and it is a private company that is under less pressure to produce financial results than a public company like Honeywell.

"There's always some doubt that Honeywell Bull will make it," Bellomy says. "But their chances are better than those of Honeywell Information Systems." □

Honeywell Bull inherited last place in the 1986 worldwide mainframe and mini markets



Source: International Data Corp.

DATABASE

A crashing halt

New orders for computers and office machinery came to a crashing halt in November, the first month after Black Monday. The $4.1 billion in new orders was down 18.5% from the previous month on a seasonally adjusted basis.

Shipments, which previously had been on the rise, fell 13.2% from October to November. The $4.3 billion value for November was the lowest monthly figure since December of 1983. Inventory, increasing 2.4% from month-to-month, absorbed the production overflow, pushing the November inventory/shipment ratio to 2.29, up from the 1.94 in October.

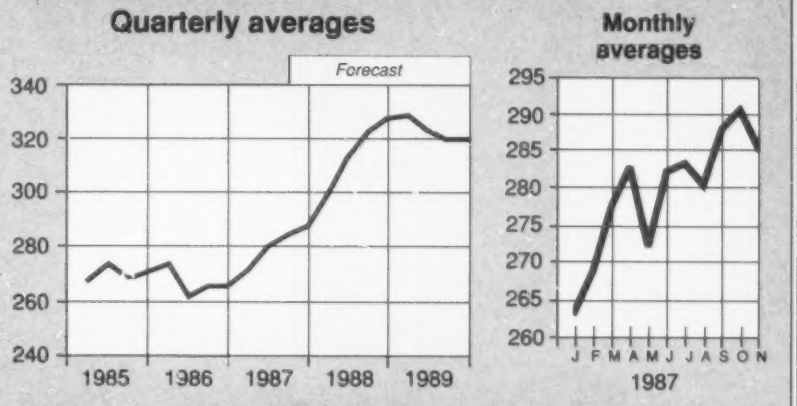
Monthly trade figures for October were disappointing given the large depreciation of the U.S. dollar. Exports of office and computing machines fell from $1,730.8 million in September to $1,693.5 million in October. By contrast, imports rose 26.7% to $2164.1 million in October. Though the trade tide has yet to turn, U.S. computer manufacturers have gained significant price advantages. From March 1985, when the value of the dollar peaked, to September 1987, the price of U.S. computers and business equipment, measured in foreign currency, plummeted 33%. Meanwhile, the price of imported units measured in U.S. dollars rose 19%.

Edited by LINDA STALLMANN

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, MA 02158 Phone:(617) 964-3030.

Industrial production index for computers

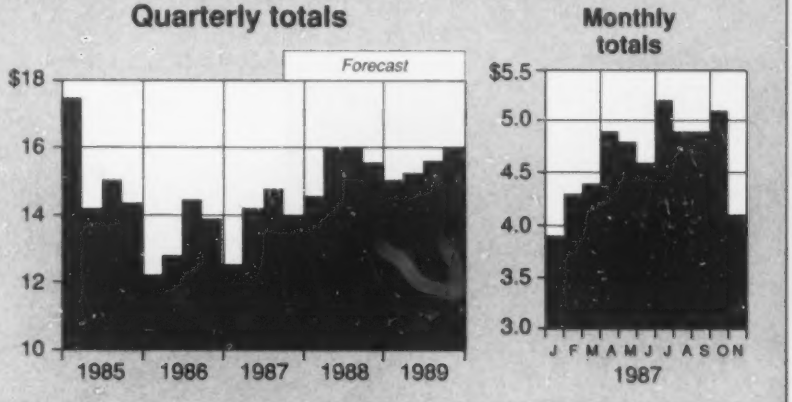
Seasonally adjusted index (1977=100)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

New orders of computers

Seasonally adjusted (Current $ billions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, November)	286.1	291.19	-1.7%	265.38	+7.8%	333.58	+16.6%
Shipments (SA, $ millions, November)	$4,275	$4,927	-13.2%	$4,562	-6.3%	$5,407	+26.5%
New orders (SA, $ millions, November)	$4,116	$5,053	-18.5%	$4,798	-14.2%	$5,228	+27.0%
Unfilled orders (SA, $ millions, November)	$19,162	$19,321	-0.8%	$19,302	-0.7%	$21,087	+10.0%
Inventory-to-shipment ratio (SA, November)	2.29	1.94	—	2.21	—	1.97	—
All employees (thousands, November)	462.3	460.1	+0.5%	463.09	-0.2%	492.37	+6.5%
Production workers (thousands, November)	152.3	151.1	+0.8%	153.5	-0.8%	159.93	+5.0%
Exports ($ millions, October)	$1,694	$1,731	-2.1%	$1,434	+18.1%	$1,798	+6.1%
Imports ($ millions, October)	$2,164	$1,708	+26.7%	$1,621	+33.5%	$1,775	-18.0%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

The Apple of their eye

The article in the Nov. 15 issue of ELECTRONIC BUSINESS entitled "A tasty treat for board makers: It's Mac tonight" [p100] discusses the new open architecture Macintosh PCs and the reaction of various board vendors to this new opportunity. I was amazed and disappointed that National Instruments was not even mentioned in your article.

At Apple's invitation, National Instruments participated in the AppleWorld show on April 2, 1987, where the Macintosh II and Macintosh SE were announced by Apple. At that show, National Instruments announced a family of seven sophisticated data acquisition plug-in boards for the Macintosh II and Macintosh SE. National Instruments was the featured plug-in hardware vendor at the show and surprised everyone with the coordinated introduction of an entire line of plug-in boards.

While other companies are evaluating the open architecture Macintosh family to decide what to do, we are shipping product in volume and already have a substantial installed base in applications including automated test and measurement, laboratory automation, chemistry, sound and vibration, biomedical, process control, calibration and communications.

RON WOLFE
Product Planner
National Instruments
Austin, Texas

Corrections

The source listed for a chart of the top database management system software vendors in the Nov. 1, 1987 issue [p68] was incorrect. The source was International Data Corp.

The contract manufacturing directory in the Dec. 10 issue should have included the following two companies:

Express Manufacturing Inc.
Chauk P. Chin
3115 W. Warner Avenue
Santa Ana, Calif. 92704
Phone: (714) 556-1878
Employees: 230
Computers and peripherals. Static-controlled electronic contract manufacturing for leaded, SMT, and mechanical assembly

Manutek Inc.
Steven D. Smith
8076 Woodland Drive
Indianapolis, Ind. 46278
Phone: (317) 872-9737
Revenue: $6.5 million
Employees: 100
Computers and peripherals: industrial; instrumentation and medical; consumer and automotive; and military. Prototype, low-and high-volume printed circuit board assembly. Through-hole and SMT; cable and wire harness assembly; engineering design; full-service purchase and material control

The market charts on pages 92 and 94 in the Jan. 1, 1988 issue incorrectly identified the revenue base. Revenue was for the U.S. market .

The Jan. 1, 1988 issue incorrectly reported that Universal Semiconductor and California Devices Inc. had withdrawn from the ASICs business ["The ASIC market: Paradise yesterday, war zone today"]. Efforts were made to ensure the validity of the data reported, which was supplied by two market research firms.

Investing? — Yes, in Nova Scotia!

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Gilles Ouimet, Senior Vice President-Operations, Pratt & Whitney Canada Incorporated

Litton Canada's decision to locate in Nova Scotia was based on the availability of a dedicated workforce, dependable supply of services, an efficient transportation network, quality education facilities and, above all, a cooperative and supportive government. All the important factors that contribute to the long term viability of a modern company.

O. K. MacLean, Director, Special Projects Litton Systems Canada Limited

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Alain Redheuil, Vice-president, General Manager, Michelin Tires (Canada) Limited.

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Research and Development Tax Credit
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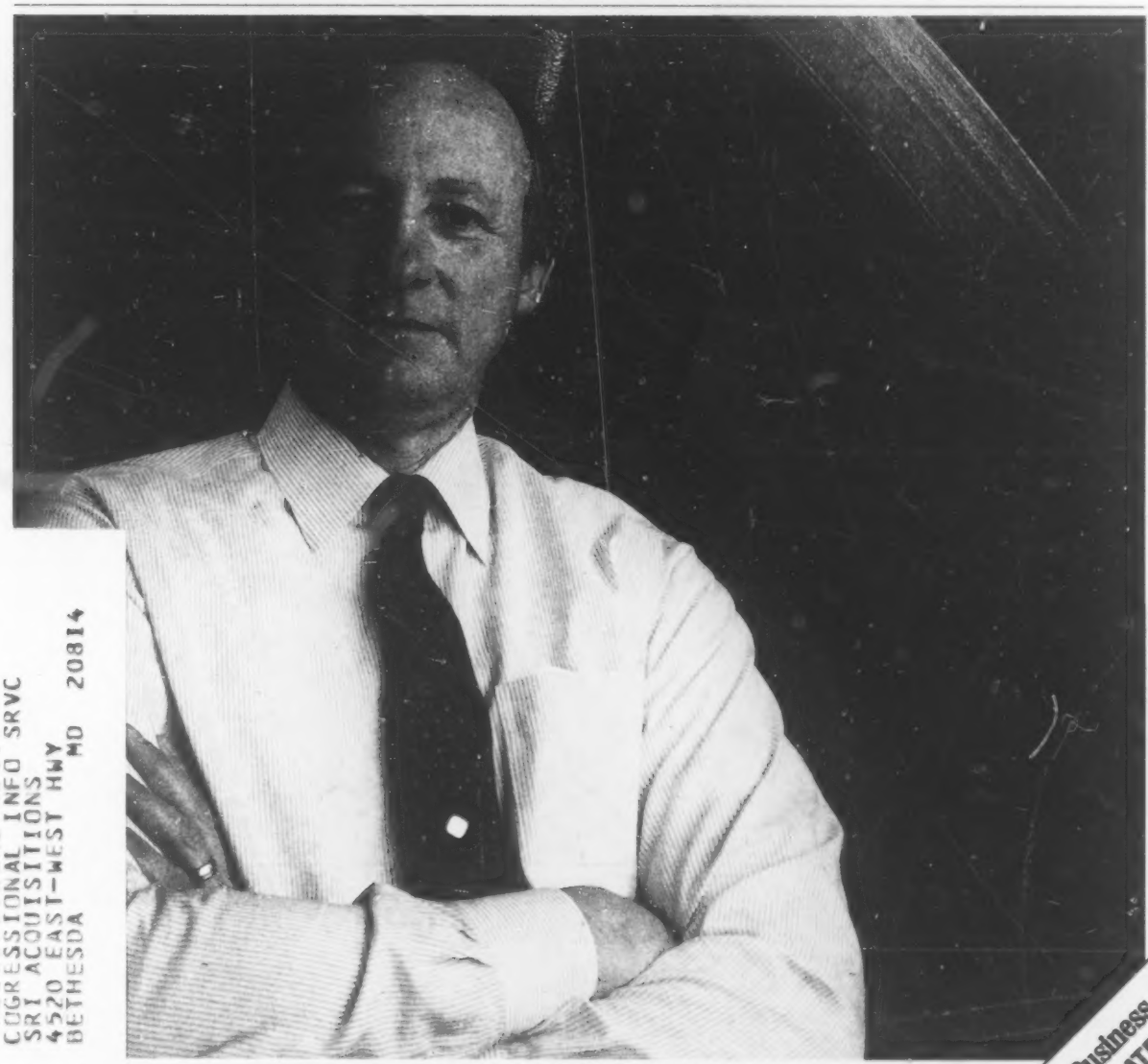
Electronic Business®

U.S. chip makers may want to feed Asia's dragons PAGE 26

Workstation vendors try third-party sales channels PAGE 64



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Cover Photo/Dave Bradley

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VBPA ABP

Printed wiring boards: The missing component

PW boards are important electronic components. Will Taiwan produce more of them in 1988?

Fortunately for the U.S. electronics industry in general — and for this editor in particular, who needs dependable statistics to evaluate the health of the industry and detect trends — the U.S. Department of Commerce includes semiconductors under the Standard Industrial Classification (SIC) 367. This category covers electronic components; and semiconductors represent almost half of this country's electronic components market. Unfortunately, however, SIC 367 does not include printed wiring boards. The reason is that half of the boards' production in the United States is captive. Since AT&T and IBM are the major producers of boards, it is simpler for the government to consider the value of the PWBs these companies produce as part of the value of AT&T's communications equipment and IBM's computers.

There are many other problems with SIC 367, but the omission of PWBs, while perhaps understandable, is nonetheless lamentable because they are the major elements that support and interconnect most of the other components in electronic and computer equipment. In value, PWBs last year represented almost 20% of the market for electronic components in the United States.

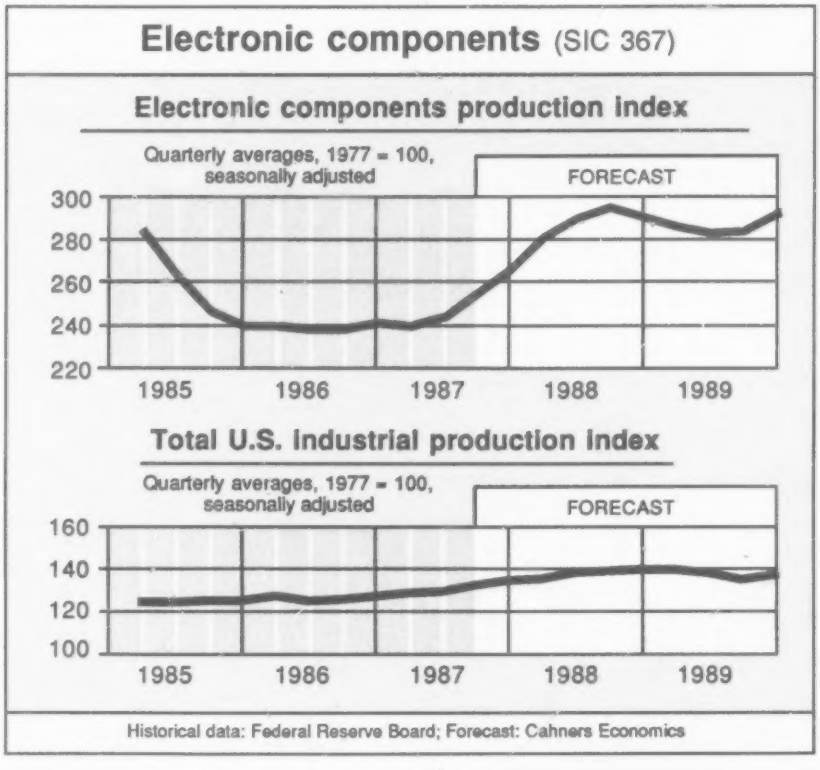
Moreover, the boards' market is far more volatile than the market for other components, even for semiconductors. The reason is that boards change not only with developments in board-making technology, but also with the changes in the components they carry.

According to The Institute for Interconnecting and Packaging Electronic Circuits, the U.S. market for rigid PWBs (single sided, double sided, and multilayer) was $4.4 billion last year, up 20% over 1986, an increase commensurate with that of the market for semiconductors. IPC's executive director Ray Pritchard attributes the gain to increasing demand, particularly from computer manufacturers, but also from firming up of prices.

However, last year, while the United States and Japan represented 32% and 39%, respectively, of the worldwide semiconductor market, they each accounted for 29% of the printed wiring boards market. The reason is that Hong Kong, Singapore and Taiwan are important producers and consumers of PWBs. Pritchard puts last year's Taiwan market for rigid boards at $0.5 billion, but notes that Taiwan is a net exporter of boards. "Many come to the U.S. embedded in personal computers," he explains. Board expert Dr. Hayao Nakahara, of Kollmorgen Corp.'s subsidiary PCK Technology, says that some of the board production that migrated in recent years from the United States to Taiwan may return here this year because the strengthening New Taiwan dollar is making their boards more expensive. However, Pritchard sees only 5% growth for the U.S. board market this year. "I'm nervous for 1988," he says.

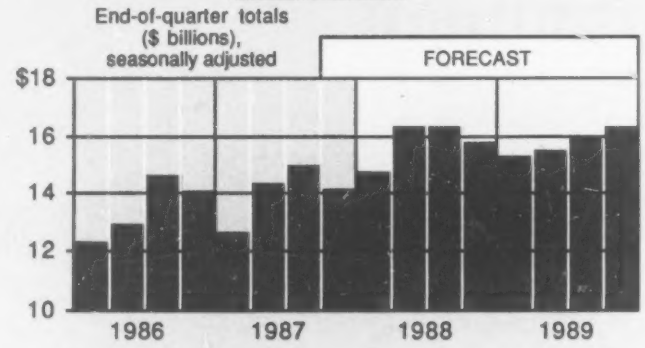
Compared with the components that SIC 367 tracks, this would be a reversal from last year. Industrial production of SIC 367 increased only 4.6% in 1987, and Cahners' senior economist Elizabeth Baatz forecasts more than 15% growth for this year. While most of this increase will be fueled by semiconductor production, Baatz's forecast, as well as those by many PWB makers, makes Pritchard's nervous estimate look very conservative.

ALBERTO SOCOLOVSKY

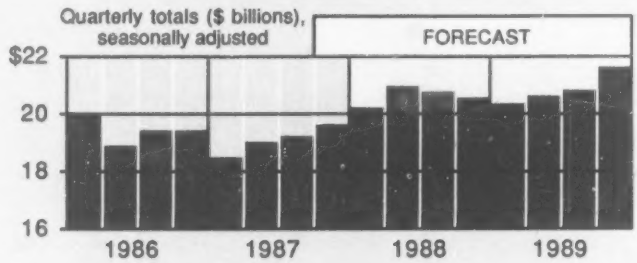


Office and computing equipment (SIC 357)

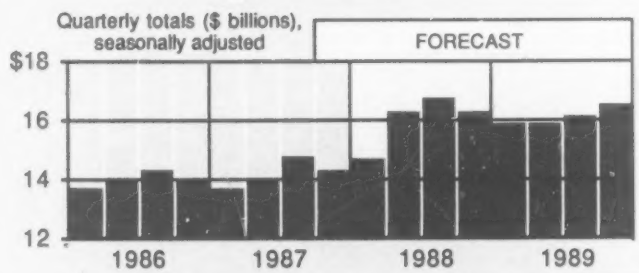
New orders



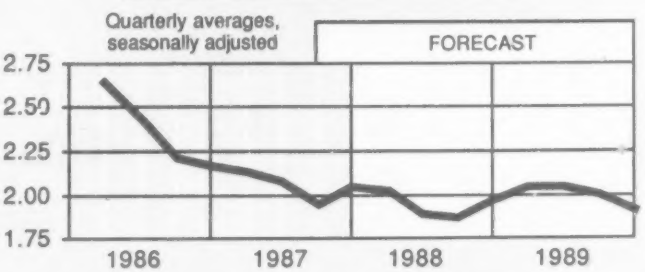
Unfilled orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

New orders for computers and office machinery were estimated at $14.1 billion on a seasonally adjusted basis for the fourth quarter of 1987, just 0.7% above the same quarter in 1986. The fourth quarter estimate brought total new orders for 1987 to $56 billion, or 4% higher than in 1986. Orders declined from $5.05 billion in October to $4.12 billion in November (-18.5%), deflating the fast growth in new orders and reducing the total for the final quarter and the year. This setback will be reversed as businesses regain confidence that the current expansion will stick. New orders are forecast to grow 12% this year, before tapering off during 1989.

Unfilled orders

In February of 1987, the value of unfilled orders hit a low of $18.5 billion after being as high as $24 billion in March of 1985. In the final quarter of 1987, unfilled orders hovered around the $19.3 billion mark, reflecting the buildup of backlogs that resulted from the earlier growth in new orders. By the end of 1988, backlogs will have grown by about 7.6% to tally $20.5 billion, a more modest growth than the 16% recorded in 1985.

Shipments

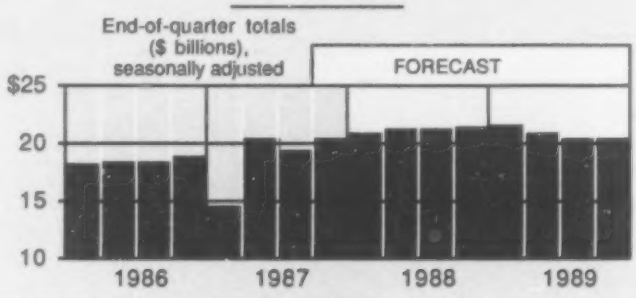
Shipments growth bottomed out at the end of 1986 and has been on a comeback since then. The recovery has been slow, however, and not without setbacks. First and second quarter shipments for 1987 were below the comparable periods in 1986. By the third quarter, growth in shipments picked up and stood 3.9% higher than the year-ago quarter. However, the October to November decline of 13.2% from $4.9 billion to $4.3 billion hurt, and brought down fourth quarter and year-end performance. The total estimate for 1987 of $56.4 billion is just 1% greater than the year before. This year, shipments are expected to be up about 13%.

Inventory-to-shipment ratio

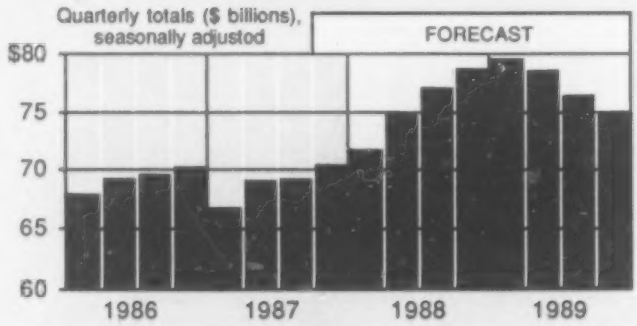
Manufacturers have been keeping a watchful eye on inventory levels. From a peak month-end figure of $13.6 billion at the beginning of 1985, inventory value dropped to about $9.7 billion by year-end 1987. The depletion and control of inventory coupled with the modest rise in shipments caused the I/S ratio to plummet from 2.65 to 2.04 over the same time period. Inventory levels will creep up in 1988, but stay well below the peak values hit in 1985. Given the better inventory management and the rise in shipments, I/S ratios will continue to head down to about 1.88 before turning upward again to end the year at around 1.97.

Communication equipment (SIC 366)

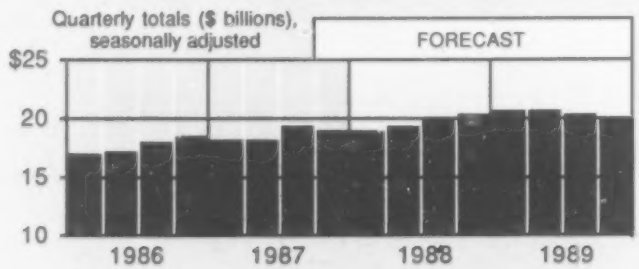
New orders



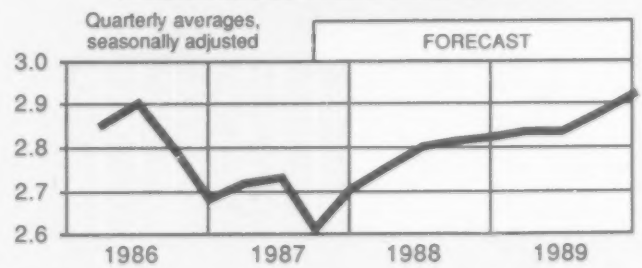
Unfilled orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

Communication equipment makers saw an erratic orders pattern in the second half of 1987. Orders fell 5.2% in the third quarter but rose 5.3% in the fourth quarter. By year-end, orders totaled just over $74 billion, a 1.6% advance over 1986 orders. About 50% of this market is dependent on military spending, so the projected slowdown in federal military purchases will keep a lid on new orders in 1988. Cahners Economics expects orders to grow 13.4% in 1988, but then fall sharply to a 2% decline in 1989. The commercial markets must pick up the defense slack in order to see a 13% gain this year.

Unfilled orders

Unfilled orders for communication equipment hit $70.2 billion last November, the highest level of backlogs ever. However, the Commerce Department only measures orders in current dollars. That means the effect of inflation is not taken into account. Most likely, after price changes, backlogs peaked in late 1986 or early 1987. The rate at which communication equipment backlogs have been growing has been on a downward path since the fall of 1985. In fact, the backlog's growth rate is at its lowest level since 1974. Orders will feed into larger backlogs in 1988, but growth is not expected to last into 1989.

Shipments

After a phenomenal 6.1% surge in the third quarter of 1987, shipments of communication equipment dropped an estimated 1.4% in the fourth quarter. That puts annual shipments for last year at $73.6 billion, a 5.8% gain over 1986. Cahners Economics forecasts another 5.6% annual gain in 1988, followed by a 3.2% rise in 1989. 1987 marked a turnaround for this industry: For the first time in six years, shipments of communication equipment to commercial buyers outpaced shipments to military facilities. Last year, about 45% of all communication equipment was shipped for military needs like radar, sonar and electronic warfare systems.

Inventory-to-shipment ratio

After falling to 2.58 in September, its lowest level in nine years, the I/S ratio rose to 2.76 in November. Still, the I/S ratio remains relatively low. In 1984, the ratio frequently hit the 3.0 mark. With the forecast for shipments in 1988 and 1989 at only 3% to 5% growth, the I/S ratio should not hit its 3.0 mark in the next year. If it does so, then excess inventory could cause production to take a cutback.

FAR EAST

Chip and equipment makers: Want to feed the dragons?

By 1992, Singapore, Taiwan, Korea and Hong Kong will consume as many chips as Europe

As one of today's most dynamic economic regions, Asia (with emphasis here on the four little dragons, exclusive of Japan) is expected to catch both the United States and Japan in the next few years in the field of information products, according to an increasing number of business executives and experts in the industry. The four little dragons, or tigers as they are sometimes called, are: South Korea, Hong Kong, Singapore and Taiwan.

Already, these four economies have demonstrated their potential in developing the semiconductor industry — a potential that promises much for U.S. equipment vendors. According to Dataquest Inc., the San Jose-based market research firm, the rest of the world (ROW) semiconductor market (mostly the Asian Pacific region, and mainly denoting the four little fire-breathers) will comprise 17% of the world market by 1992, roughly matching Europe's share.

Adds C.D. Tam, vice president and general manager of Motorola Inc.'s Asian/Pacific semiconductor products region: "Looking at the established infrastructure, underlying strength, culture and ethics, and the continued transfer of electronic equipment manufacturing to the Asian Pacific region, our conclusion is that semiconductor consumption (a measure of electronic and equipment production) will catch up with Europe before 1993. This conclusion is important as it portends the gravitational shift of global electronics."

In 1987, ROW consumed an estimated $4.9 billion worth of semiconductors. That conceals some strong growth figures: Dataquest reports that ROW chip consumption jumped 55.6% in 1986 and 38.1% in 1987, compared with 6.5% and 12.7% respectively in North America, 44.9% and 14% in Japan, and 17.2% and 10% in Europe. As a result, the ROW share of worldwide semiconductor consumption rose to 11.4% in 1987, up from 1986's 9.5%. In 1988, the rate is expected to advance further, to 12%, compared with Europe's 16.7%.

Asia's four dragons: Korea, Singapore, Hong Kong and Taiwan

Armen Kojoyian

Additionally, the region is becoming increasingly self-reliant in chip making, producing in 1986, $1,292 million worth in South Korea; $689 million worth in Taiwan; and chips worth $169 million in Hong Kong and $1,177 million in Singapore.

The vigorous development of ROW's information product market represents substantial business opportunities for both materials and equipment suppliers. Despite the remarkable growth of their production capacity, ROW economies still rely very much on outside IC suppliers. Equipment sales for the electronics industries in Taiwan and South Korea are 2.5 times higher than the world average, notes Robert Tsao, president of United Microelectronics Corporation (UMC) of Taiwan. For instance, demand for IC production and testing equipment by IC makers, and for workstations by IC design houses, is growing significantly.

In view of these prospects, LTX Corp., which produces digital VLSI test systems and networks, has established sales and support centers for its equipment in Singapore, Taiwan and Japan. "Some of these centers are not economically justified, if based on short-term business alone, but are a way of saying to our current and potential Asian customers that we are here [in Asia] for the long term," remarks James Healy, senior vice president at LTX.

In 1987, four leading IC makers in the region all registered remarkable sales growth: Goldstar Co., with $85 million in sales and a 44% growth rate; Hyundai Electronics Industries Company Ltd.,

$35 million, 75%; Samsung Group, $250 million, 47%; and UMC, $100 million, 42%. UMC just broke ground for its new VLSI plant, which will require an investment of $200 million for a monthly capacity of 30,000 6-inch wafers.

IC design capability has also been developing rapidly in recent years. UMC, for instance, started its in-house design in 1984 and has turned out 50 to 60 new products annually ever since. In fact, in the first half of 1987 it brought out 100 new products. This is the major reason for the handsome profit being enjoyed by the firm. In 1987, the company reaped $20 million in profits, against revenue of $100 million. IC design houses began emerging in Taiwan in 1980 and in 1987 their number topped 30.

In the most advanced area of very large-scale integrated circuits, Asian production will catch up with that of the United States and Japan in five years, according to Tom Wang, an associate director for Dataquest.

Wang points out that there are four major factors which will help Asian economies achieve the goal. First, is the growing local demand. Second, is government support, as the governments of the four little dragons all have special institutions to carry out VLSI research.

The third factor is that leading IC makers in the region are spending heavily on R&D projects. The corporate capital and R&D spending of Samsung topped $220 million in 1985 and $127 million in 1986; Goldstar expended $107 million and $90 million in the respective two years; and Hyundai unloaded $141 million and $31 million for R&D in the two years.

And finally, the substantial market potential, along with the availability of very qualified but inexpensive engineers, has induced a growing number of international IC makers to seek joint ventures with their counterparts in the region. In South Korea, Samsung has formed a strategic alliance with Micron Technology for the production of 64 kilobit and 256K DRAMs memory chips, and with Intel Corp. for 8-bit microprocessor units, EPROMs, and 256K DRAMs. Also, Goldstar is working with Advanced Micro Devices Inc. on 64K and 256K DRAMs, and with LSI Logic Corp. on CMOS gate arrays. Meanwhile, Hyundai has link-ups with ICT on EPROMs; with Vitelic

Semiconductor usage in the rest of the world — mostly in the Asian Pacific region — is growing much faster than anywhere else...

Semiconductor consumption
(Percentage change from previous year)

	1986	1987	1988
North America	+6.5%	+12.7%	+23.4%
Japan ($)	+44.9%	+14.0%	+19.0%
Japan (yen)	+1.9%	+9.0%	+19.9%
Europe	+17.2%	+10.0%	+19.9%
Rest of world	+55.6%	+38.1%	+28.2%
Worldwide	+25.6%	+15.1%	+21.6%

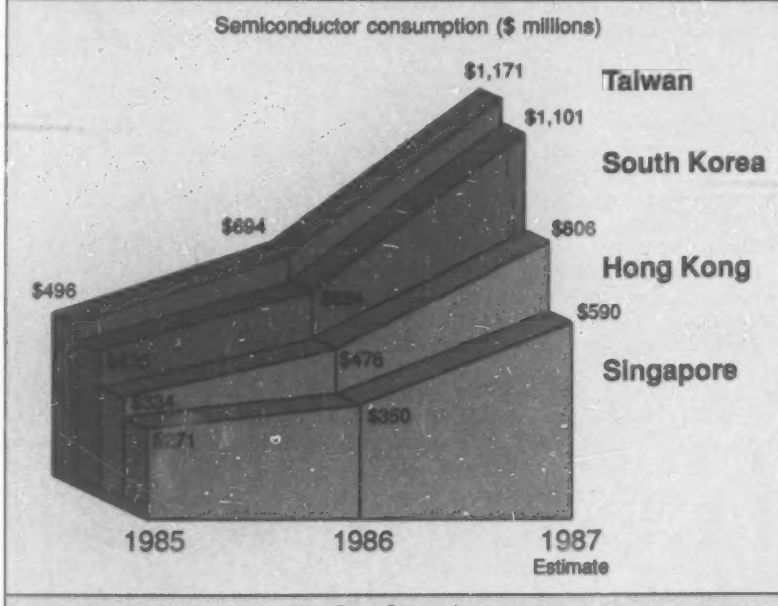
...so that it will match Europe's semiconductor consumption by 1992

Semiconductor consumption ($ billions)

	1987	1988	1992
Japan	$14.5	$17.4	$27.5
United States	$12.5	$14.2	$20.2
Europe	$6.8	$7.5	$11.9
Rest of world	$4.9	$6.3	$11.8

Source: Dataquest Inc.

Asia's four dragons are hungry for chips...



Source: Dataquest Inc.

Do yourself a service
Let ELECTRONIC BUSINESS readers know about your services

Next August 15, ELECTRONIC BUSINESS will publish its annual directory of Services for the Electronics Industry. If your company can help other electronics and computer companies complete a project on time, save costs, reduce risk, get to market faster and safer, increase efficiency, improve quality, or any other pertinent electronics service, the name of your company or division, and the type of service it provides for our readers, belong in the pages of the ELECTRONIC BUSINESS directory.

Example of services that will be listed:

Design: product design, circuit design, custom ICs, design centers, software development, package and packaging design, thermal design, documentation.

Manufacturing: contract manufacturing, printed circuit design and fabrication, mass lamination, purchasing services, kitting services, value added services, cabling, connector assembly, quality assurance service, just-in-time services, component procurement services, production software services, electrostatic discharge protection services.

Test: electrical test services, environmental testing, failure analysis, instrument rental services, test software development, production testing.

IC Foundry: silicon, CMOS, custom processes, gallium arsenide.

IC Assembly: die attachment, wirebonding, packaging, marking, sorting.

Distribution: services by and for industrial distributors, distribution channels, dealers, packaging for distribution and retailing, point of sale services.

Training: quality training, statistical production control, JIT training, purchasing, negotiating, management training.

Management: product strategy, global strategy, international operations, management consulting, temporary additions to management team.

Marketing and Sales: strategy, market research, product strategy, product position, sales representation, product promotion, export promotion, advertising, public relations.

Financial: leasing, banking, insurance, venture capital, mergers and acquisitions.

Transportation: freight forwarding, air cargo, customized packaging.

How to submit your listing:

- Name, address and telephone number of company or division that performs the service. If available, add telex and fax numbers.
- Type of service: Please be specific. (If you enter in more than one category, such as design and manufacturing, please list separately.)
- Name of managers(s) responsible for services for electronics and computer companies. Include direct telephone number, if available.
- Current volume of sales of this type of service to electronics and computer companies.
- Number of employees at this company or division, involved in this type of service.
- Specialized equipment, knowledge, and/or capabilities, which qualify your operation to perform this service. (Please list or describe in 50 words or less.)
- Name of at least one client among electronics and/or computer companies.

Send your entry, before April 30, 1988, to:

Services, Alberto Socolovsky
ELECTRONIC BUSINESS
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Wayne, PA 19087
Phone: 617-964-3030 • Telex: 94-0573CPCBSN • Fax: (617) 964-5490

Electronic Business

Corp. for 64K, 256K and 1Mb DRAMs; and with Texas Instruments Inc. for 256K DRAMs. At the same time, Daewoo Electronics Co. Ltd. is working with Zymos Corp. on standard cells. In Taiwan, UMC cooperates with Synertek Inc. for producing microprocessors. Taiwan's governmental VLSI research institute also has joint projects with Vitelic for 256K DRAMs.

High-end chips too

In fact, the attraction of the market potential and abundant engineering talent have induced a growing number of foreign manufacturers to establish their manufacturing bases in the region, not for low-end, but for high-tech products. SGS Semiconductor (Pte) Ltd., an Asian subsidiary of the Italian IC maker, is a case in point. One major factor which induced SGS to start its assembly factory in Singapore in 1969 was the low labor cost in the region. But over the years, the

In VLSI circuits, Asian production will catch up with that of the U.S. and Japan in five years

picture has changed substantially. Through a continuous program of training and investment, the company has seen this plant rise from manufacturing epoxy transistors at 1 million to 3 million per month to making complex ICs at a rate of over 30 million per month. The plant now manufactures over 500 product lines in a "clean environment." The firm's sales topped $100 million in 1987, compared with $10.5 million back in 1980.

In addition to this successful partnership, SGS has established a similar plant in Malaysia. It has made a great effort to train local engineers and managers, transferring both management skills and know-how. Comments Antony Watts, director of strategic planning for the company: "We believe that in the future, fewer and fewer corporations will make up the semiconductor industry, and those large enough to stay in the line will form closer cooperative links to users."

PHILIP LIU

Liu is a business writer based in Taiwan

TRADE

U.S.-Canada trade pact: Good news for electronics

There's more to it than easier cross-border sales of PBXs, modems and switches. It could help ease future patent tiffs

For the electronics and telecommunications industries, the pending U.S.-Canada free trade agreement is a "win-win" kind of a deal.

That's the word from industry executives on both sides of the border and from U.S. government officials who negotiated the historic free trade pact between the world's two largest bilateral trading partners.

The agreement, which still must be approved by the Canadian Parliament and the U.S. Congress, would phase out all bilateral tariffs over 10 years and establish a controversial dispute settlement mechanism to resolve trade conflicts between the two nations. It would take effect Jan. 1, 1989.

For the telecommunications industry, there's a little-noticed kicker added to the free trade pact, literally at the 11th hour: an agreement to speed up the elimination of tariffs on both sides of the border on such key products as switches, PBXs, telephone handsets, modems and parts. "On the bulk of these items, the phaseout will be immediate," discloses one mid-level U.S. official closely involved in the telecommunications negotiations.

What this means is that there will be immediate free trade on a wide range of telecommunications products starting next year, assuming that the Canadian Parliament and the U.S. Congress approve the overall trade pact. Under the original agreement, initialled by negotiators on Oct. 3, 1987, there was a gradual five-year tariff phaseout on most of these products. Especially important will be the immediate dropping of the current 17.5% tariff in Canada on telephone sets and PBX switches.

"The removal of tariffs on telecommunications was accelerated in the final agreement," confirms Peter Murphy, who headed the U.S. negotiating team at the Office of the United States Trade Representative, the executive branch trade agency. "Some were moved from a 10-year phaseout down to five years, but most were moved from five years to zero... We think this should satisfy the industry."

Indeed, the telecommunications sector — and the electronics industry in general — seems pleased by the prospect of the pending new trade pact. "The pact is sure to help our industry expand markets, reduce costs and improve our products," says Oliver Smoot, executive vice president of the Computer and Business Equipment Manufacturers Association. CBEMA and AT&T were prime movers in lobbying to remove the 17.5% tariff in Canada on telecom equipment coming from the United States.

PRESIDENT REAGAN and Canadian Premier Brian Mulroney signed the free trade pact in January. Reagan noted that it will save U.S. consumers "hundreds of millions of dollars"

Reuters/Bettmann Newsphotos

Historic achievement

When President Reagan and Canadian Prime Minister Brian Mulroney signed the free trade agreement in early January, both hailed the pact as an historic achievement. Reagan stressed that the agreement will benefit consumers on both sides of the border, noting that it will save U.S. consumers "hundreds of millions of dollars while also improving our export opportunities."

Mulroney, for his part, asserted that the signing sends "a powerful signal toward liberalized trade around the world," an assertion that highlights a significant aspect of the free trade pact. It is likely to provide some important spadework for progress on the new round of multilateral trade negotiations — the Uruguay Round — under the auspices of the General Agreement on Tariffs and Trade (GATT). Some major problems for both countries which have an impact directly on the electronics industry — disputes over copyrights and patents and the whole area of intellectual property — were left for multilateral resolution within the new GATT talks.

But first there is the question of approval by the legislative bodies in both countries, a procedure which everyone acknowledges will take some time. In the United States the

key players in trade policymaking on Capitol Hill, notably Sen. Lloyd Bensten (D-Texas), chairman of the Senate Finance Committee, and Rep. Daniel Rostenkowski (D-Ill.), of the Ways and Means Committee, have made it clear that they will hold up consideration of the landmark free trade agreement until June 1 to give Congress time to first consider the wide-ranging omnibus trade legislation known as HR 3 in the House.

Administration officials, however, want fast Congressional action on the free trade agreement. Industry insiders in Washington think that Congress will prevail on this point, noting that extensive committee work on the omnibus trade bill is already well underway and that this will be handled ahead of a congressional review of the free trade deal. In the end, most analysts think Congress will okay the pact.

It's important to note that Congress will have to act quickly, something that could be difficult given the relatively scarce number of real working days scheduled in this election year and a full plate on other issues. Once the implementing legislation on the free trade agreement is introduced in Congress, both the House and the Senate will have 90 legislative days to finish their review and then cast what essentially amounts to an "up or down" vote approval.

It's expected that the Canadian Parliament will act on the new agreement well ahead of the Congress, possibly as early as this month. Opponents of Mulroney, expecially Liberal leader John Turner and New Democratic Party leader Ed Broadbent, are expected to mount an all-out attack on the free trade accord. "It's not a trade deal," says Turner. "It should be called the Sale of Canada Act."

Incensing the politicos

There are many aspects of the agreement which incense opposition leaders in Canada. But a major point of contention in Canada is that the Canadians were unable to win the outright exemption they sought from U.S. trade laws, most notably the anti dumping and countervailing duty actions which have been filed in fairly significant numbers against a range of Canadian products in recent years. Turner and others argue that the deal is thus "flawed" from the Canadian vantage point because it fails to provide secure access to the U.S. market.

Trying to guess the outcome in Parliament is probably even more difficult than predicting what Congress will do, but most trade analysts do think that Mulroney will be able to carry the day and push the trade agreement through Parliament.

One aspect of the pending free trade agreement that is sure to cause plenty of debate in both nations is the dispute settlement mechanism. As described by one U.S. official, who asked not to be identified, all final dumping and countervailing or subsidy cases would go to a binational panel of lawyers who would "adjudicate" the case on the basis of existing law in the importing country.

One study estimates that the U.S.-Canada free trade agreement will increase the U.S. GNP by 1% and Canada's GNP by 7%

"Either side can take a case to this panel," this official says. "Private parties can bring cases, too." There would be five members on the dispute settlement panel, two from each country and a fifth who is "mutually agreed upon." Panel decisions would be binding.

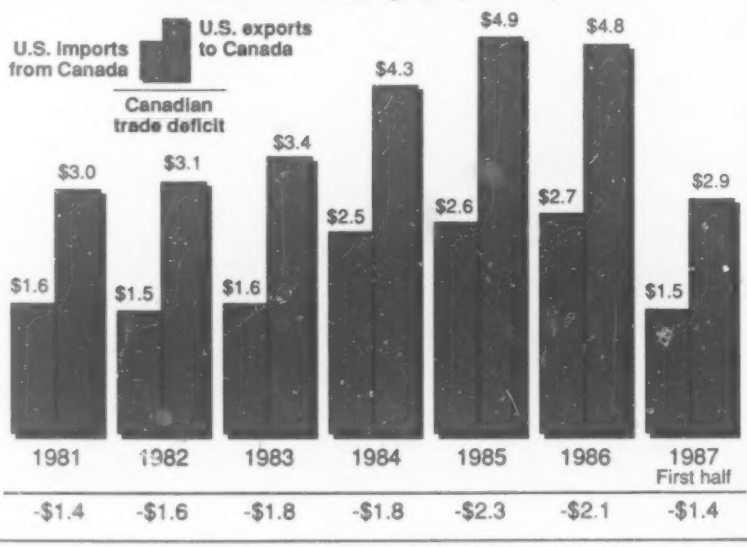
Another wrinkle which might be worth keeping an eye on after the agreement comes into place: a provision that if either the United States or Canada makes changes in their trade laws, they can ask for a special advisory panel to determine if those changes are consistent with the GATT and the U.S.-Canada FTA. This would be a separate three-judge panel, sources say.

Despite all the legal twists and turns, many of which may not be fully understood by U.S. businessmen, there's no question that the wide-ranging trade agreement is an historic achievement. A study by Michael Aho for the Council of Foreign Relations estimates that the FTA will increase Canada's Gross National Product by as much as 7% and that it will increase U.S. GNP by about 1%. "What we've got here is a win-win agreement," Murphy told a meeting of the American League of Lobbyists.

MARTYN CHASE

Chase is a Washington, D.C.-based business writer

Will the trade pact widen Canada's electronics trade deficit with the U.S.?



Source: American Electronics Association

SEMICONDUCTORS

Why RISC chips are giving CISC a run for the money

The nifty new species of microprocessors boasts blazing speed. But their simplified design may be their undoing

By Valerie Rice

It's sleek. It's fast. It's elegant. It can leap tall calculations in a single cycle. It's RISC, and it's coming to your local semiconductor vendor some time soon.

For systems designers trying to choose the next generation microprocessor architecture, the decision process is now even more difficult. With the introduction of a slew of new RISC microprocessors in the last nine months, it's not just a choice between Intel or Motorola anymore.

In fact, when systems designers go shopping for RISC today, they have a pretty good chance of shopping from one of their competitors, like Sun Microsystems Inc., rather than their traditional suppliers. For the likes of Intel Corp. and Motorola Inc., the market dynamics have also changed. They no longer just compete against other semiconductor companies. Now they are competing with their customers.

RISC, for reduced instruction set computers, works on the "less is more" theory: 20% of a machine's instructions are activated by users 80% of the time, so the instruction process is streamlined down to just the bare minimum and the software does the rest. Traditional microprocessors, or CISC (for complex instruction set computers), contain a full instruction set and are less dependent on power software.

The essence of RISC, then, is raw speed. RISC processors are commonly two to five times faster than traditional versions; some can be 10 times speedier. For over 85 announced systems and board level companies, raw speed is enough, as they have eschewed the well-entrenched traditional processors offered by Motorola and Intel and gone maverick.

Catering to that maverick market are a number of firms including workstation maker Sun Microsystems with its SPARC architecture, Advanced Micro Devices Inc., Intergraph Corp., MIPS Computer Systems Inc., Motorola Inc. and just recently, United Technologies Corp.

RISC chips from these vendors and undoubtedly others will own 20% of the 32-bit market by 1992, according to market research firm Dataquest Inc. Another researcher, Integrated Circuit Engineering Corp. (ICE) is even more optimistic: analysts there predict that RISC will account for 35% of the market by then.

Where will these RISC chips go? According to ICE, of the 35% of the 32-bit market that RISC chips will own, 20% of them will be in workstations, 5% in office automation or PC applications, and 10% in the "other" category, comprising military and embedded control applications, among others.

"There is finally enough evidence to show, once and for all, that RISC is a superior way to build a microprocessor," claims recent devotee Steve Blank, marketing vice president of Ardent Computers Inc.

But don't sound the death knell for traditional microprocessors yet. RISC chips may have found their niche in high-end workstations and compute-intensive applications, but ownership of markets in low-end workstations, office automation and personal computers in general still be-

longs to the traditional microprocessor vendors.

Besides, RISC vendors face unique challenges. Despite recent significant design wins, analysts feel that RISC chips may not be viable commercially in the long term. Ease of design has made many companies today choose to design their own chips, rather than depend on third-party suppliers.

Why they take risks

The profile of a "RISC taker" is a company that is playing in the engineering or scientific workstation market, that is eager to differentiate itself, and, probably most importantly, is not squeamish about changing architectures.

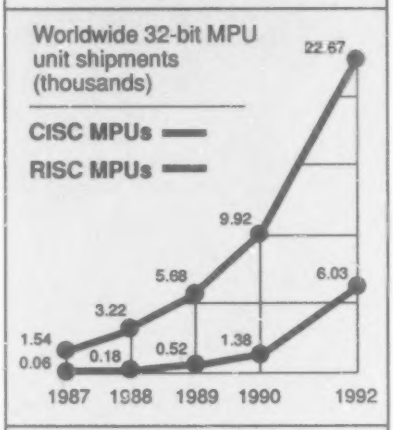
"We believe we can get a factor of two performance advantage using the RISC technology," says Forrest Basket, vice president of R&D for workstation maker Silicon Graphics Computer Systems. Of his recent decision to use the MIPS RISC architecture for his future generation of products. "You can't ignore a factor of two."

One of the downsides of RISC, Basket believes, is that the software programs have to be bigger, thus requiring more memory. "But you're buying more computing power for memory prices," he says. "That's not such a bad deal."

"The bottom line is you get the same chip, the same size and same power, but it is much, much faster," says Ardent's Blank. "And the price is certainly no more than for CISC," he adds, "It may be even less; at worst it is equal."

Blank acknowledges that writing the extra software is a hassle, but notes that "you either have to worry about building the computer, or write more software. It's worth the trade-off."

RISC will own 20% of 32-bit MPU market by 1992



Source: Dataquest Inc.

RISC chips have also come along at a time when many companies are looking for ways to further differentiate themselves from competition. Prime Computer Inc., for example, wanted to develop a workstation product for the first time, and a RISC chip seemed to offer the best performance for the high end, says Edward Vrablick, director of workstation products.

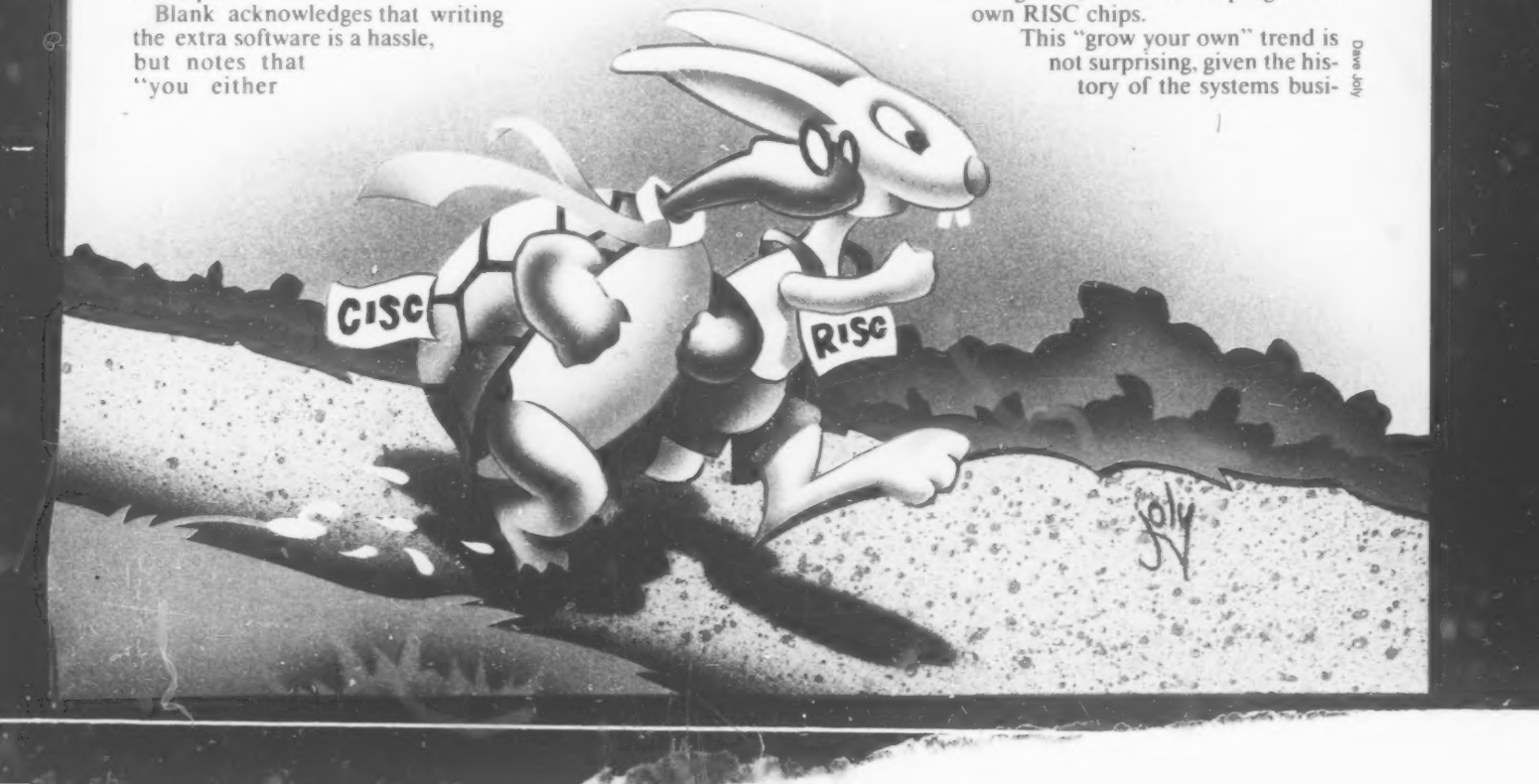
Prime's current product is a "super" workstation targeted at the high-end CAD/CAM market, Vrablick says, and the company is working on unannounced RISC products as well. Prime, which is using the MIPS architecture, says it chose MIPS because it had the most advanced compiler technology, which Prime used to overcome the largest RISC barrier — software compatibility.

Another recent convert to RISC is Xerox Corp.'s document-processing systems division. Xerox is using Sun's SPARC architecture to support its first step into the world of standard, nonproprietary platforms. Xerox wanted to choose Unix to power its document-processing systems, and the Sun offering, strengthened by its very close ties to AT&T, made the most sense, says Bruce Gitlin, Xerox's strategy implementation vice president.

As if the RISC phenomenon wasn't confusing enough, with users buying from users and suppliers competing with customers, there is another wrinkle. For every RISC design win, there are probably five that don't go to Sun, AMD or MIPS. But that is not to say that those companies aren't heavily involved in RISC. The essence of RISC — streamlining — makes the chips very easy to design, and the end result is often a homegrown one.

RISC chips are so easy to make, in fact, that many companies, including Digital Equipment Corp., Hewlett-Packard Co., IBM, Ridge Computers and others are making their own in a bid to retain a proprietary hold on their customers. Rumors abound that companies like Apollo Computer Inc., Apple Computer Inc., and Compaq Computer Corp. are following suit, and developing their own RISC chips.

This "grow your own" trend is not surprising, given the history of the systems busi-



ness, says Andrew Rappaport, president of market research firm Technology Research Group. The development of third-party microprocessors is an aberration, he declares. "Before the invention of the PC, there was no such thing as a merchant microprocessor. Everything was proprietary. With RISC, we may see the trend swinging back. . . ."

Rappaport believes that this trend toward internal development of RISC chips may make it difficult in the future for third-party RISC vendors to find much of a market. Systems companies have "hung on to third parties," Rappaport says, because the high development costs of CISC microprocessors have made that necessary. Now with "RISC simplifying the design, it is more feasible for a company to engineer its own processor. You have less of an advantage using a third-party RISC chip than a third-party CISC chip."

"Where are all these RISC people going to sell their chips?" asks Dataquest analyst Alice Leeper. "There are some serious questions about the commercial viability of this architecture."

Those RISC companies are probably not going to find much of a market at IBM. The RT PC — IBM's engineering PC — is alive and well, with substantial order backlogs, according to Andrew Heller, vice president and general manager of the Advanced Engineering Systems group within the Entry Systems Division. IBM's RISC machine has shown success in the technical market and in office automation applications, Heller says. And IBM is unlikely to look elsewhere for RISC technology.

One way that IBM may be able to retain a strong grip on the RISC market is through development of a RISC chip that can optimize PC-DOS applications. Although Heller refused to confirm whether or not IBM was in the process of developing such a system, he notes that "it is conceivable that you will see such a system in the very near future, from IBM or someone else."

HP would not be a good candidate to switch to current RISC offerings on today's market, according to Doug Spring, general manager of HP's communication systems group. The primary reason, Spring says, is that today's market offerings are optimized for workstation applications and are not broad-based enough to appeal to HP's diverse user needs, particularly at the high end.

That narrow focus is one reason that DEC has yet to release a commercial RISC offering, says Don McInnis, DEC's engineering systems group vice president. Digital has been researching RISC for more than five years, to the point of manufacturing beta test systems, he says.

But for Digital's customer base, RISC is not the solution right now. "It doesn't offer a broad range of advantages for a broad range of customers," McInnis says. "Performance is not the only issue."

The night of the living hybrid

One of the more interesting fallouts from RISC technology has been the hybridization of existing CISC microprocessors. The next generation of CISC microprocessors from Intel and Motorola is already being touted as having "more RISC functionality."

Clearly the two technologies will merge with each other in the future, creating hybrid-like products that will hopefully offer the best of both architectures. However, many users are somewhat skeptical about a company's ability to make a CISC chip RISC-like. "There's nothing RISC-like about the 80486 or the 68040," contends Ardent's Blank, referring to the next-generation CISC microprocessors being developed by Intel and Motorola, respectively. "It's a marketing definition, nothing more."

Yet "there is always a need for compatibility for DOS-based systems," Dataquest's Leeper says. "I just don't see CISC going away in favor of RISC. CISC can use whatever technology has been learned from RISC machines."

To address those needs, Intel plans to make its 486 chip more RISC-like, more streamlined, Intel group vice president David House says, but it will add those extra transistors necessary to retain software compatibility.□

The YARP syndrome: Intel and Motorola enter the fray

It seems that RISC chips are practically crawling out of the woodwork today, compared to several years ago when the idea was considered to be on the "lunatic fringe." "I call it the "YARP" syndrome," Intel's microprocessor vice president David House says, "for 'yet another RISC processor'."

House is somewhat contemptuous of the flood of recent RISC offerings. "RISC is seen as an opportunity for all the 'have nots' in the computer architecture business to gain a foothold," he adds.

Yet even House admits that RISC has its place. However, for Intel, which has an active R&D effort in RISC, that place will likely be in embedded control applications that do not affect sales of the company's bread-and-butter 80386 product family and its installed software base.

Analysts point out, however, that Intel has less to lose from RISC design wins. Technology Research Group's Andrew Rappaport says that Intel, because it has a stronghold in PC products and not in the workstation area, is largely protected from losing design wins to RISC processors. At risk, he adds, is Motorola, "since all of the recent design wins for RISC hit Motorola where it hurts — in workstations."

That's not the way Motorola sees it, however. "If my competition thinks I am losing design wins, so much the better," declares Motorola's microprocessor marketing manager Jack Browne. "I can lull them into complacency that way."

Browne remains undaunted even though Motorola has not been scoring many design wins for its new 68030 at companies like Silicon Graphics. Sales of all the 68000 product lines are still going strong, he claims, and that trend will continue because of the strength of the installed software base. Browne's trump card, certainly, must be the company's recent announcement of a RISC microprocessor.

Details about the processor are sketchy, although performance is said to be 17 MIPS. The "88000," as it is known is a "major product for the company," with an R&D budget of $20 million, Browne says, although it is in no way a replacement for the 68000 family.

And when Motorola starts shipping the 78000, Browne says, "I'm going to get my customers back."□

WORKSTATIONS

New Age marketing: Now workstations are channeling

Vendors try channeling — third-party sales channeling — as price wars force them to adopt new distribution strategies

By David Card

As the list price of an engineering workstation is slashed — seemingly weekly — bringing it closer to that of a PC, workstation makers are being forced to open new distribution channels. If they don't pry in this year, they may be locked out forever.

"With the prices of workstations tumbling and the cost of salesforces going up, economically it becomes nonsense to sell your products all direct," says Stephen Haslett, value-added channels manager for Hewlett-Packard Co.'s Technical Systems Sector, where HP's workstations originate. An entry-level machine from any of the major suppliers, which two or three years ago cost $40,000, these days sells for under $5,000. "Long gone are the days when all you needed was a red-hot salesforce," Haslett sighs.

Once, workstations sold exclusively into the computer-aided design and engineering market. Now they are branching out into publishing, manufacturing and even office automation — applications long the turf of value-added resellers. And a new wave of personal computers is usurping workstation characteristics like tight networking, high-resolution graphics, powerful operating systems (usually Unix) and 32-bit central processors (usually Motorola Inc.'s 68000 series). PCs powered by Intel Corp.'s 80386, a 32-bit chip, can run variants of Unix and the IBM/Microsoft Corp. OS/2.

Thomas Kucharvsky, president of Boston market research firm Summit Strategies, says that historically, 60% of workstation sales are direct, compared to only 15% of PC sales. Workstation makers have to hurry to get into the cheaper third-party channels. "Especially with the way '386s are coming on," Kucharvsky says. "There's such an incredible demand for them." He adds that the PC companies "already have channels established. Workstation vendors have to start from scratch developing them." Besides VARs, there are distributors and even retail outlets to court.

Market research firm International Data Corp. of Framingham, Mass., estimates that the 7-year-old workstation market reached $2.47 billion in 1987 world sales by U.S. suppliers. This year the total will climb to $2.88 billion, but $475 million of that will go to '386-based machines and the Macintosh II PC from Apple Computer Inc., which uses the 32-bit Motorola chip. IDC also expects workstation leader Sun Microsystems Inc. to do well with its '386 machine.

Sun and the other workstation makers, including Apollo Computer Inc., Digital Equipment Corp. and HP, have gotten off to a "relatively slow start" in the VAR channel, according to IDC analyst Stephen Bosley. Even DEC and HP, which do just fine in the third-party business with their minicomputers, have yet to see more than 10% of their workstations go through VARs and distributors, adds Summit's Kucharvsky. And he estimates that companies with fewer than 500 employees will buy half of the 32-bit engineering and publishing hardware in the next five years. Those small, tough to reach companies already buy 70% of all PC-based CAD.

IDC's Bosley says the workstation

HP's HASLETT: Long gone are the days when all you needed was a red-hot salesforce"

Liane Enkelis

companies have to help VARs develop custom software. "Otherwise, everybody gets caught in the commodity game — the MIPS [millions of instructions per second] battle," he says. "Everybody loses in that. Sun has traditionally done better at that than the others, but sooner or later, even they will lose their shirt."

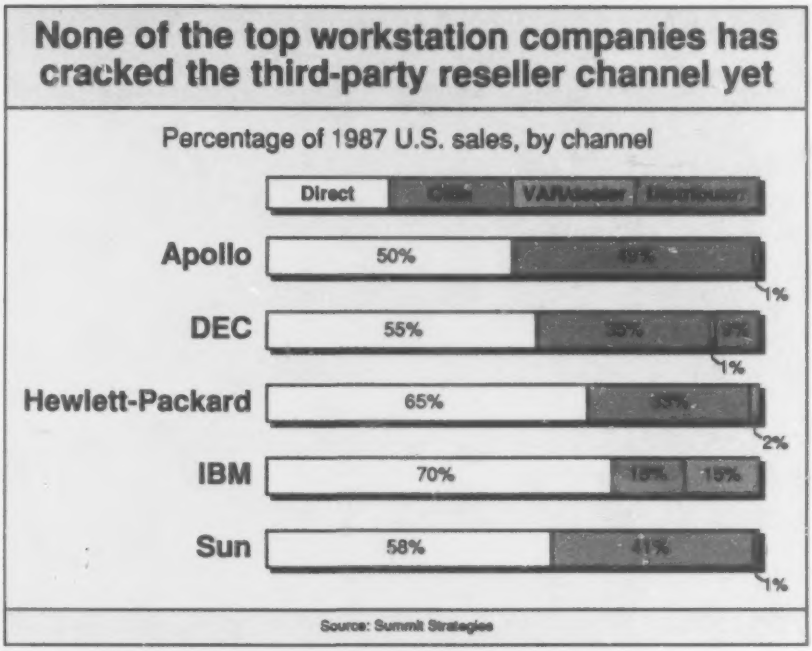
Sun has no intention of losing its shirt. Vying to retain its reputation as the hottest computer kid on the block, and eager to continue its torrid 150% yearly growth pace, Sun is launching a cross-country road show this month to spread its gospel to VARs. "We did the standard VAR mailing, about 5,000," says Sun sales vice president Joseph Roebuck, out of Mountain View, Calif. He admits to feeling some pricing pressure, but says the main reason for VAR-wooing is to help out smaller software companies that have no access to third-party channels.

Roebuck says Sun's VAR program got under way last year but sales so far "are not worth talking about." Mechanical and electronic CAD, architecture and publishing are Sun's first target markets — nothing overtly commercial yet. Roebuck would be happy to sign up 100 VARs from the trip and "ecstatic" to get a couple hundred. He doesn't see any reason to make a cutoff mark. "Limits are self-limiting," he says with the bravado characteristic of his company.

Personal CAD Systems Inc., a seller of PC software for the design of circuit boards, switched from direct sales to VARs, after a brief flirtation with manufacturers' reps. Business has been booming since, says PCAD president Douglas Stone. His marketing vice president, Michael Lack, says that he found that only 60 or 70 VARs could really handle PCAD software. Those generally also carry packages in the markets Sun is interested in, and Lack thinks a few will go with workstations as well. But not many. "An even smaller number are capable of supporting workstations," Lack claims. Of course, PCAD software competes with any number of circuit board design systems incorporating Sun hardware. But IBM and Apple are thinning their dealer ranks, qualifying fewer dealers to carry their 32-bit PCs.

Sun's arch rival Apollo of Chelmsford, Mass., started its third-party program nearly a year earlier than Sun — in December 1986 —but was more low-key about it. Apollo was also interested in software. "We got requests from some of our larger accounts," specifically Boeing Co., says Apollo's director for market development, William Kelly. "They wanted software on workstations instead of PCs," specifically, AutoCAD, the ubiquitous drafting package from Autodesk Inc. "It was just another mechanism to get software on our platform," Kelly says, "so we went with the wiles of the dealers." In terms of getting software, the program was successful. It was less so in terms of getting sales, Kelly says.

None of the top workstation companies has cracked the third-party reseller channel yet



Historically, 60% of workstation sales are direct, compared to only 15% of PC sales

Discounting prices

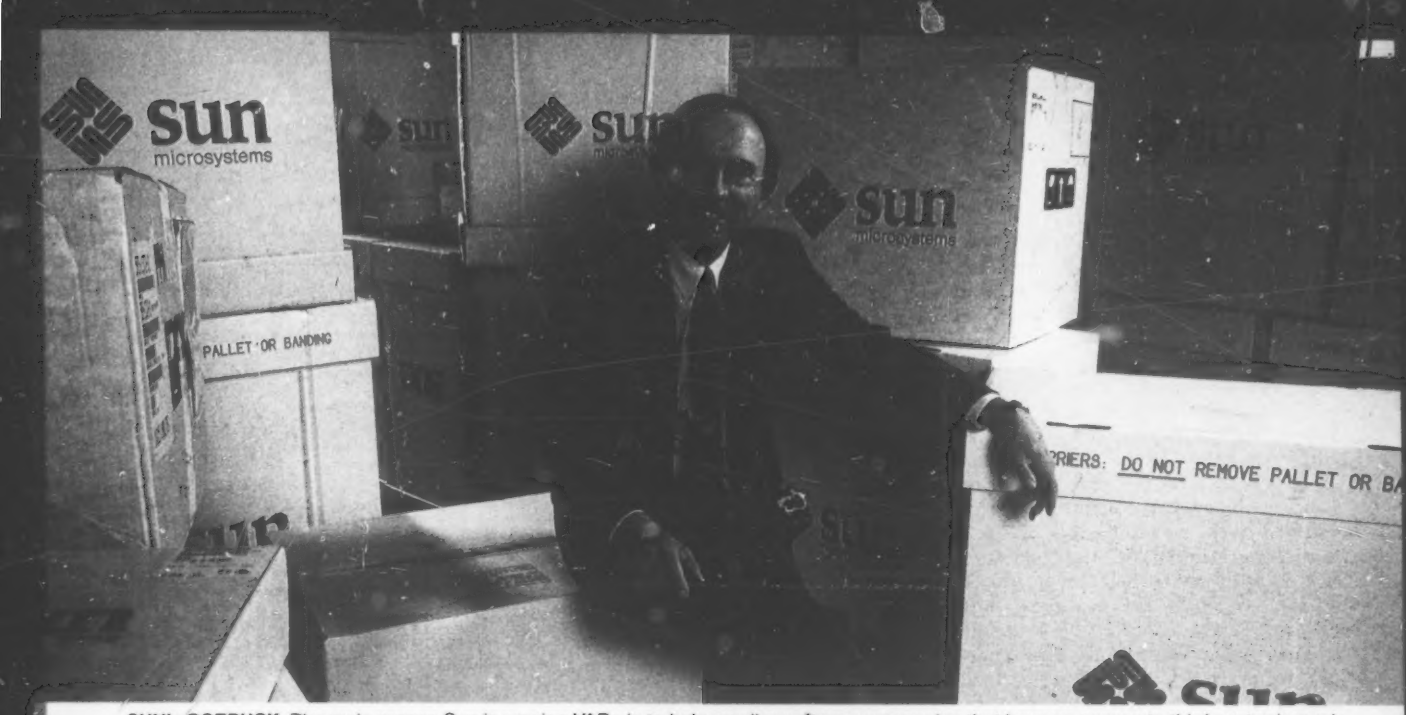
Apollo went with a finder's fee system. Leads from dealers went back to Apollo, which actually took the purchase order and handled the shipping, support and so forth. Nobody will talk specifics about their discount structures, but most VARs and dealers are used to discounts of up to 40% for volume sales. Apollo paid a 20% finder's fee, according to Kucharvsky at market researcher Summit. Kelly says Apollo is now examining a system similar to its original equipment manufacturer (OEM) discount schedule, which has more generous discounts.

Gordon Medlock, president of National CADD-Pro Inc., says it will take discounts of 40% to 50% before he will make a major commitment. National CADD-Pro is a consortium of six big regional dealers that are merging into a single operating entity to enable volume purchasing agreements. Together, the dealers would have sales of over $20 million, Medlock claims, and probably be headquartered where Medlock's region is centered, in Syracuse, Ind.

The member organizations already carry Apollo and Sun, as well as PCs from Compaq Computer Corp., IBM, Intel and NEC Corp. Medlock is a PCAD VAR, and sells mechanical CAD and manufacturing software on the workstations. Sun gives better discounts than Apollo, Medlock says, and as for DEC, "Well, we're talking to 'em." He adds: "Sun is the most aggressive and enlightened in marketing. They understand what dealers need in the way of support and discounts." He likes NEC's efforts, too.

Medlock has no problem with supporting a variety of hardware: "In terms of price and performance, anybody that's got the numbers gets invited to the party." This view is the polar opposite of at least one major industrial distributor. Wyle Laboratories carries DEC hardware, including its workstations, as well as Wyse Technology's '386 PC and a multiuser system from Convergent Technologies Inc. "Apollo, Sun; my gosh, how could we even remember enough product knowledge to keep up?" laments Wyle's vice president of computer products, Jim Hunt.

Wyle carries Tektronix Inc. graphics terminals to plug into DEC minis, but Hunt is not interested in Tek's



SUN's ROEBUCK: The main reason Sun is wooing VARs is to help smaller software companies that have no access to third-party channels

new workstation. Besides, Tek's workstation people have not called on Wyle. "We wouldn't be a good candidate," Hunt says, because he wouldn't want to upset DEC.

But National CADD-Pro glories in multiple suppliers, even in managing different operating systems, which is usually a support nightmare. "At the present time, there appears to be a DOS/Unix dichotomy," Medlock says, referring to the dominant operating systems for PCs and workstations, respectively. "The two never meet, but they have to communicate with each other. That's our business."

Integrated Graphics Systems Inc. is a Denver VAR that has not yet moved upscale from PCs to workstations. But president Steven Bruny says he advises Hitachi Ltd., whose CAD software he resells on a variety of PCs, to keep options open. "We advise them to make all future developments Unix-based as well, so when the U.S. turns to Unix, we'll be ready."

Conflicting channels

Besides discounting, there are other things the workstation companies are doing to encourage indirect marketing channels. HP's newest graphics subsystem for its workstations "was designed with a lot of input from software developers and VARs," Haslett claims. "The result was almost mundane" by HP perfomance standards, he says, but that's what the not-so-silent majority wanted. HP has a high-performance graphics workstation, the 850, to keep the power users happy.

HP is in a rather prickly position. It has hundreds of VARs for its peripherals division and a lesser number for its commercial minis and "Vectra" PCs. But the company has not exploited them for its workstations. "The reason we haven't," says Haslett, "is that we're being very cautious. The opportunity for channel conflict is enormous." HP doesn't want too many of its resellers competing with each other, let alone have them fighting off HP salespeople.

"The key is for vendors to compensate their direct salesforces for VAR sales," says analyst Bosley. "It comes down to money." All of the workstation makers have some kind of commission program. HP goes one better. PCs sold for technical applications show up on Technical Sector scorecards, even though the PCs are made by HP's commercial division. The whole situation is a little self-balancing, Haslett says. A salesman "is not going to spend a lot of time selling one Vectra when he can sell a $100,000 Model 850," he says.

Workstation makers have to hurry to get into the cheaper third-party sales channels

One of Sun's tactics to keep conflicts to a minimum is a tight set of geographical boundaries for its VARs. "It's a very, very strict value-added program," Roebuck says. "We're going to control what is sold." For instance, Sun will allow only two or three VARs, four at most, Roebuck says, in the San Francisco Bay area, each with a different application focus. HP's Haslett feels that a program like that would be restrictive: "Certainly, the VARs we work with would not be comfortable in that situation."

Kelly of Apollo sees more trouble for Sun, once its '386-based model reaches the streets. "They're going to run into horrendous channel conflicts because they'll have competing products," he warns. Treading warily was one reason behind Apollo's original finder's fee set-up, Kelly says.

In PCs, Apple reserves 70 or so key accounts for its direct salesforce, allowing its retailers a shot at every other company. Kelly says Apollo might "look at something in that vicinity." But Sun's Roebuck maintains that the Apple strategy is not for him. "We've got to make sure our own sales channel does not compete with the VARs," he says. "Every company is available to our VARs."

Analyst Kucharvsky thinks it will be an "uphill battle" for the workstation-only makers to crack the third-party market. He's more positive on the broad-range computer companies. Workstations do have in their favor the widespread price slashing of PCs on the street, Kucharvsky says. So far, end users are seeing less price fluctuation: although the workstation makers themselves are locked in list price wars, their resellers' profit margins are reasonably intact. Also on the workstation makers' side is their applications and customer base — what Kucharvsky calls "a big carrot." Most resellers haven't sold engineering systems to aerospace giants like Boeing. □

Lane Erickson

COMPONENTS

Express mail for electrons: The new wave in interconnect

The search for higher interconnect speeds is leading to more use of fiber optics and development of high-density connectors

By Michael Leibowitz

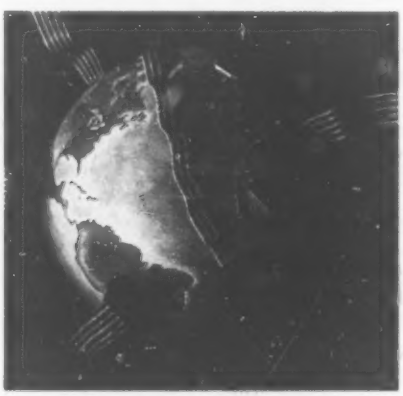
In their efforts to tap the full performance of today's semiconductors, systems builders are becoming more reliant on interconnect technologies to help speed the electrons from chip to chip. In a previous issue of ELECTRONIC BUSINESS, developments in surface mount technology, chip packaging and materials were explored. But two other areas promise faster connection of electrical signals: the new high-density connectors and fiber-optics data links.

The big trends in connectors are toward the use of fewer but more sophisticated connectors. "The connector is generally being pushed out from the middle of the system," says Nicholas Pearne, president of market research firm BPA Ltd., "as more of the heartland of the system is done on silicon or on high-density substrates."

That does not mean that the connector business is fading away. The U.S. connector business garnered a respectable 11.5% growth in 1987, reaching $5.2 billion, according to another market research organization, Fleck Telesis. While growth rates are unlikely to return to the 20% to 30% figures of the 1970s, Fleck expects a modest growth averaging 5.5% a year over the next five years. This growth will be driven, in large part, by increases in the number of electronic products being produced.

According to Kenneth Fleck, president of the Huntington Beach, Calif., market research firm, DIN connectors have registered the fastest growth of any connector product line during the past four years, racking up $50 million of sales in 1987. He expects the DIN's popularity as a reliable, sturdy 2-piece backplane connector to continue, garnering an additional 14.1% in market value each year. With 47 suppliers selling DINs into the U.S. marketplace, "price competition has been very severe," says Fleck. Prices have fallen 50% in the last four years and DINs are currently selling at as little as 1 cent per position.

Today's fastest growing connectors feature pin-counts of 100 pins and up, with the newest designs squeezing these pins into .050-inch center-to-center spacing and below. This is in contrast to the under 100-pin, .100-inch spacing connector of yesterday. Fleck estimates that the market for high pin-count connectors will grow from $62 million in 1987 at a rate of 25.4% per year. High-density connectors (with pin spacing of under .100-inch) will mushroom at the rate of 51% per year, from $37 million in 1987. Prime users will be in the high-performance computer and telecommunications industries.



Today's fastest growing connectors feature pin counts of 100 pins and up

At least 25 major suppliers sell high pin-count or high-density connectors into the U.S. market, according to Fleck. Forget about standards for awhile, however. Besides the ploy by some makers of extending the standard, 96-pin DIN connector to 150 or more pins, manufacturers have gone off in their own proprietary directions. Second sources for many of these new connectors are nonexistent.

Packing in the pins

AMP Inc.'s AMP-HDI connector is a good example of the state of the art. The 2-piece connector family packs as many as 684 pins in four rows on .100-inch spacing and is used in connecting daughter boards to a backplane or motherboard. According to Frank Pertschi, AMP's marketing director for new business development, key customers for these connectors are high-performance computer makers. A new version, called HDI-50, has recently been introduced and packs its pins on .050-inch centers, to consume half as much space.

Burndy Corp. of Norwalk, Conn., has avoided the problem of high insertion and extraction forces by designing its Ziflex card-edge connector family with a cam that is used to bring the contacts into place when the board is mated. The zero-insertion force Ziflex features from 60 to 300 contacts on .050-inch center spacing and boasts a unique surface-mounted design: No soldering is required; the connector is screwed into place and sharp, high-pressure points establish electrical contact with the solder pads of the printed circuit board.

Burndy's work in card-edge connectors revives the controversy over whether or not card-edge technology (in which the "male" portion of the connector consists of etched and plated "fingers" along the edge of the printed circuit board) is suitable for high pin-count, high-speed connections. Critics of card-edge abound,

Martin Dooley

and say that card-edge provides a less reliable, electrically dirty and mechanically inferior connection than 2-piece connectors (in which the "male" portion is a molded piece containing pins that interlock with the "female" receptacle). Such critics point to the worldwide popularity of the 2-piece DIN connector as proof that the market views 2-piece connectors as the wave of the future.

But proponents argue that a properly designed card-edge connector offers advantages over 2-piece connectors, such as electrical balance, low cost and mechanical simplicity. Card-edge connectors avoid tiny pins on .050-inch centers that can be easily damaged. Proponents also point out that IBM chose to use a Burndy card-edge design for its Micro Channel Bus in the PS/2.

"IBM has breathed new life into card-edge and the whole industry recognizes that," says Fleck. But still, continues Fleck, the overall card-edge market is in a "mature product phase." Although some special card-edge types may be moderately successful, including new high pin-count and surface-mount designs, the $340 million card-edge market as a whole will register a minimal 2.2% annual growth over the next five years.

Fiber optics are faster

Lift your eyes out of the cramped quarters of advanced electronic gear and increasingly, you will see fiber optics being used to interconnect equipment in offices, oil fields and across oceans. While datacommunications applications represent a $171 million portion of the $700 million fiber-optics market (with the major share eaten up by telephone applications), the segment is expected to burgeon to $813 million in 1992, according to Kessler Marketing Intelligence (KMI), a market research firm based in Newport, R.I.

Speed, of course, is the big advantage of fiber over alternatives such as twisted pair and coaxial cable, and KMI projects that speed-intensive applications, such as point-to-point computer interconnections and local area networks, will lead fiber-optic's datacommunications growth over the next five years. The firm says the fiber-optics market for point-to-point computer applications will grow an average of 19%, while fiber-optic use by LAN makers will skyrocket an average of 75% per year in the same period.

But John M. Kessler, KMI's president, points out that fiber optics has other advantages as well, so he expects to see other applications represent 45% of the 1992 fiber-optic market. Fiber optics is a natural in industrial environments for factory automation, where electromagnetic energy from motors and other sources can cause interference on cable lines. It eliminates any chance of sparking, a definite plus in flammable environments such as refineries. And it is difficult to tap, a consideration wherever security is important, as, for example, in foreign embassies.

But the immediate question facing the fiber-optics business is not what the market will look like five years out. "The real question," says William Hackett, AT&T's manager for product marketing for light-wave components, "is when is it really going to ramp up? It's going to be big. The question is when."

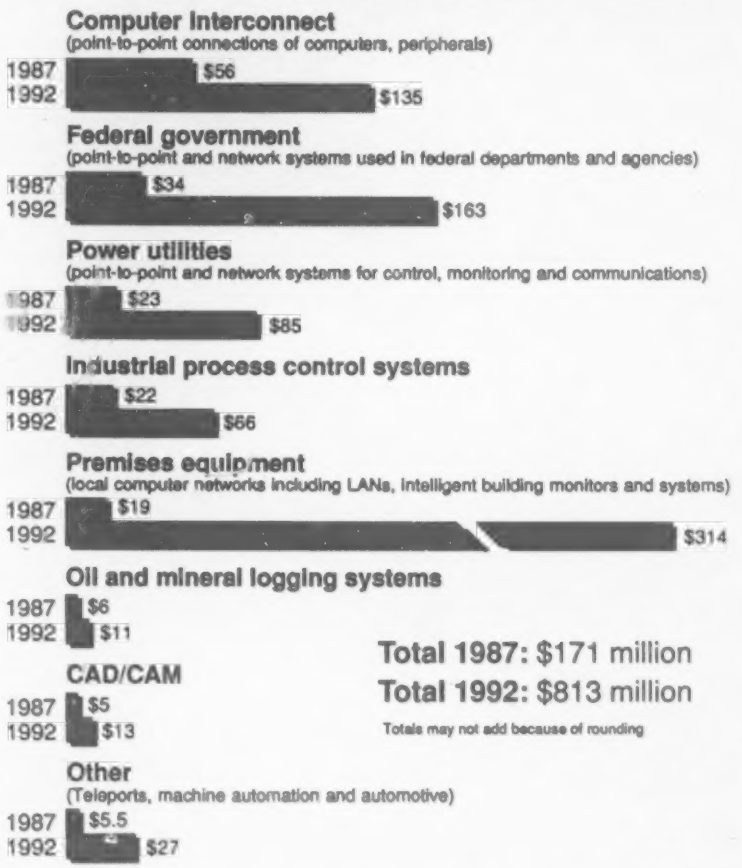
According to Hackett, near-term questions include customer acceptance, or whether end customers will decide that the advantages of fiber optics are worth its cost premium. Another barrier is lack of standards, while the main standard, the 100 megabit-per-second Fiber Distributed Data Interface (FDDI) remains unresolved by an American National Standards Institute committee. Hackett also says that equipment makers' varying level of comfort — with unfamiliar fiber-optic cable, connectors and apparatus — will be a determining factor in the short-term market.

Hackett acknowledges the difficulties of the datacommunications segment and admits that the market's performance over the next few years is unclear: "It's an emerging market. And I would be suprised if anyone's making money in that particular market."

But, he says, the datacommunications fiber market is going to be big. "We hope to see some big business in the early 1990s in both computer interconnnect and local area networks." □

U.S. consumption of fiber-optic products

Includes connectors, cable and receivers/transmitters ($ millions)



Source: Kessler Marketing Intelligence

Computer makers change the fabric of their software strategies

A look at how the top four U.S. computer makers are fitting software into their future

By Mary Jo Foley

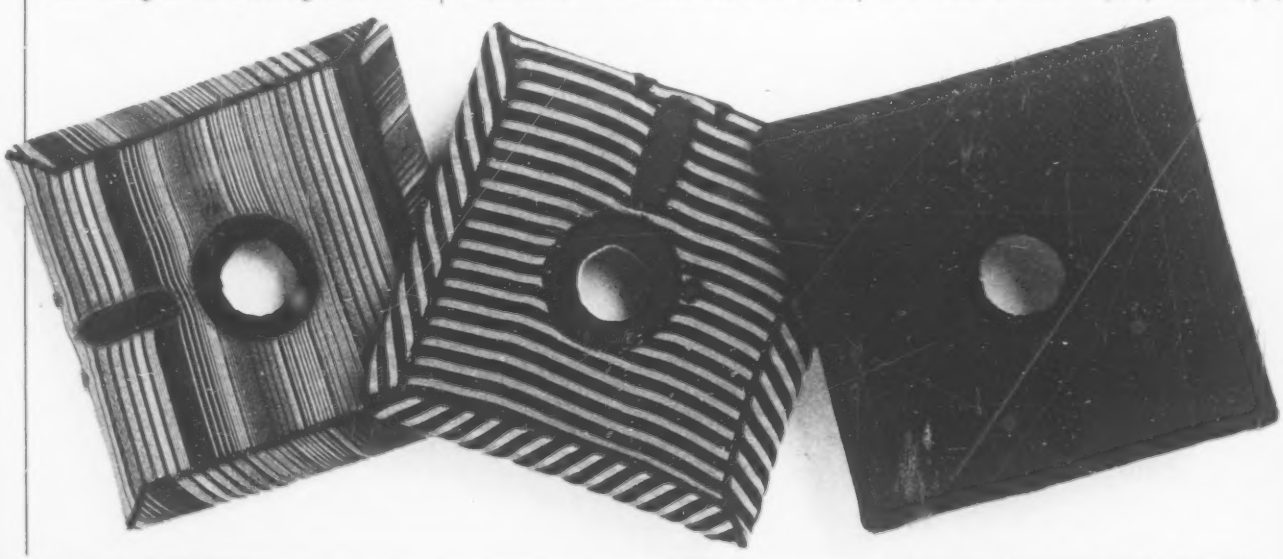
In the early 1980s, IBM predicted that in the next decade, one-third of the company's revenue would come from software. That prediction may still prove accurate, but gone are the days when any hardware maker will attempt to draw such distinctions. In fact, except for accounting purposes, few, if any, computer vendors calculate software and hardware revenue separately. The focus these days is on meeting the customer's needs, through the provision of hardware, software, or both, they claim.

This kind of slick yet subtle software rhetoric is a must for today's computer vendors. In a world where hardware margins are continuing their downward descent, while software margins are holding their own, hardware vendors cannot afford to ignore software as a key source of revenue. Besides, software is an emerging point of differentiation among hardware vendors, as well as between computer companies and the brash, younger — and many times, cash-rich — independent software vendors, or ISVs.

The results of this increasing emphasis on software already are apparent. In 1986, IBM garnered $5.5 billion, or 11.1% of its total data-processing related revenue, from software sales, according to estimates prepared by *Datamation* magazine. Unisys Corp. derived $861 million of its total DP dollars from 1986 software sales. Digital Equipment Corp. racked up $560 million in software revenue, and Hewlett-Packard Co. amassed $375 million from its 1986 software sales. These figures include operating systems, tools and utilities, and applications — packaged and turnkey. And market research firm International Data Corp. predicts that the top computer vendors' software revenue will skyrocket 20% to 30% per year until at least the end of the decade.

While these figures are impressive, U.S. computer vendors cannot afford to rest on their laurels. For, with the additional exception of Wang Laboratories Inc. (which derived $200 million from software in 1986, according to *Datamation* estimates), the rest of the top 15 DP companies in software are either foreign-based computer makers or ISVs.

Part of the reason U.S. computer vendors have not increased their software revenue more rapidly than they



Margaret Cusack

Top software vendors have a hardware look

Software revenue of top data-processing companies[1]	1986 software revenue ($ millions)	Software revenue as a percentage of total DP revenue
IBM	$5,514.0	11.1%
Unisys	$861.0	9.1%
DEC	$560.0	6.7%
NEC	$507.1	8.0%
Fujitsu	$389.2	5.9%
Siemens	$387.1	8.8%
Hewlett-Packard	$375.0	8.3%
Hitachi	$331.0	7.0%
Nixdorf	$299.5	14.4%
Lotus Development	$283.0	100.0%
Microsoft	$260.0	100.0%
CGE[2]	$238.1	23.2%
Computer Associates	$226.5	85.5%
Olivetti	$225.3	5.8%
Wang Labs	$200.0	7.5%

[1] Data-processing revenue includes income generated from mainframes, minis, micros, peripherals, datacommunication equipment, software, maintenance and other services

[2] Compagnie Generale d'Electricite

Source: *Datamation*

have is due to their basic corporate structure and orientation, according to Framingham, Massachusetts-based IDC analyst Peter Burris. "These companies are structured to sell hardware and understand the risks involved. Software is new. The risks are much higher. In software, you can really lay an egg," Burris says.

In addition, while these companies want and need to compete with ISVs, they also need to cooperate with them. Striking the right balance between competition and cooperation has proven to be a major stumbling block, even for IBM. This obstacle is, by far, more prominent in applications and tools than in operating systems software, almost all of which is written and supplied by hardware vendors. IBM's ongoing love/hate relationship over operating systems and applications for PCs with microcomputer software supplier Microsoft Corp. of Redmond, Wash., is one of many examples of this tension.

In the so-called integrated office arena — where all of the major computer vendors market one or more in-house developed applications (such as DEC's All-In-1 and IBM's Profs and Disoss) — the cooperative/competitive strain is especially high. And in rapidly expanding, hot new markets, such as distributed databases; networking and communications applications; desktop publishing; and other graphics applications, computer vendors are bumping into ISVs more and more regularly.

A fairly recent development which is enabling many vendors to smooth out the rough edges in their dealings with ISVs is the "spectrum" approach to third-party programs. Rather than dealing with ISVs on an ad hoc basis (as IBM admits it has tended to do in the past), or by trying to pigeonhole all third-party relationships into one or two narrow categories, all of the major computer vendors now seem to provide ISVs with a range of choices in their dealings with them. Even though each vendor has its own name for its particular programs, all seem to offer similar terms and conditions. These programs run the gamut from simple cross referencing of software, to joint marketing or development. Actual buy-outs of ISVs or their products now seems to be a thing of the past.

Besides strategic alliances, there are several other common software issues computer vendors need to address, according to Michael Cohn, an analyst with the Mountain View, Calif., market research firm, Input. These include:

- adherence to emerging industry standards;
- inter-line compatibility—a problem most vendors seem to be at-

tempting to solve via common "application environments," like IBM's Systems Applications Architecture and HP's NewWave; rather than via common operating systems, like DEC's VMS;

- intra-line compatibility, or the ability to communicate and share data in "mixed," or multiple vendor, environments;
- software integration, or the need to be able to supply in-house developed or third-party software in multiple areas: the one-stop shopping approach;
- the need to offer more than "just" software — for instance, professional services, education, training, and, increasingly, computer-systems integration skills.

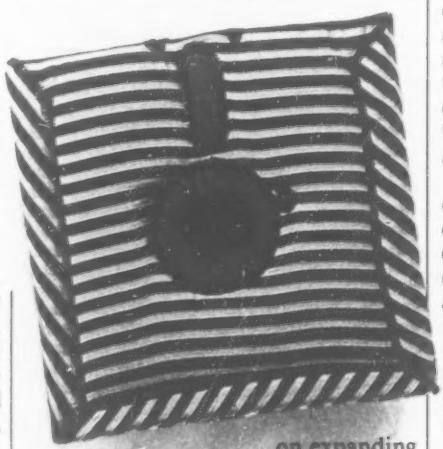
Despite these commonalities, each U.S. computer vendor is taking a fairly different path — in terms of its software organizational structure, marketing, sales and distribution strategies. Highlights of the software strategies of the top four U.S. computer vendors follow.

IBM

Application software division hits the ground running

Last year, IBM added two new acronyms to its repertoire, which sum up succinctly its emerging software directions: Application Systems Division (ASD), and Systems Application Architecture, (SAA).

ASD, headquartered in Milford, Conn., is IBM's hub for application software support worldwide. Although much of its initial activity since its formation in July has centered on beefing up IBM's midrange software offerings, ultimately it will develop and acquire applications for all IBM hardware. In order to do this, the division is concentrating heavily



on expanding its third-party software options — especially through its cooperative software program and marketing assistance program (MAP). IBM's announcement last year that Lotus Development Corp. would develop and co-market a mainframe version of its popular 1-2-3 spreadsheet is seen as only the first of many such third-party software coups to come. The National Solutions Center, a database of application packages available from IBM, currently lists about 3,500 application packages, 500 of which were developed internally by IBM.

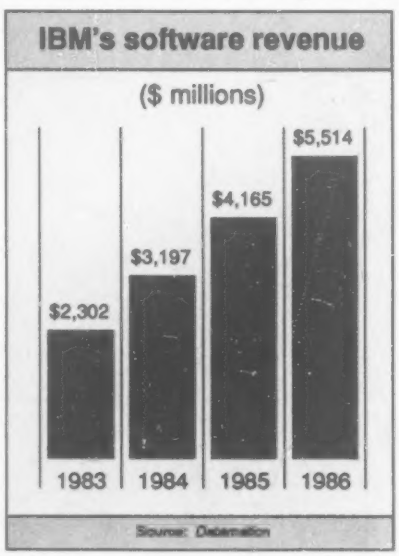
"Once we announced ASD, we were overwhelmed by letters from ISVs [independent software vendors]. In fact, we're still digging out," says Robert Berland, vice president of the vendor and development operations segment of the division. "Before July, companies didn't know how to approach us. Now there's a focal point."

ASD consists of five subdivisions: application development systems and integration; computer integrated manufacturing systems; finance and general systems; office systems; and Berland's vendor and development operations. All five are connected via SAA, which is IBM's master plan for providing a common software environment across its primarily incompatible microcomputers, minicomputers, and mainframes. Announced last spring, SAA is a collection of user interface, programming language, and communication standards. They are detailed in various technical manuals, which IBM is in the process of making available to independent software vendors and end users alike.

The application development systems and integration subdivision is charged with ensuring that all ASD and third-party software products comply with SAA. The subdivision also is responsible for most IBM tools and utilities. Berland's division — through its establishment of SAA education and support groups for the third-part community — also plays a key role in IBM's SAA strategy.

In short, "IBM is becoming more open in terms of working with the outside," Berland says. Big Blue has come to realize that "software vendors are critical to the success of IBM and its customers. When we created the division, one of its major thrusts was to energize the software community to build on IBM — even if the software may directly compete with IBM [developed] software."

This admission that even a $51 billion company may not have enough money and expertise to succumb to the "not invented here syndrome" is a new departure for IBM. The company is expected to continue to write and enhance many applications for all levels of hardware itself. But, as Berland acknowledges, "There's a trend toward the concept of seeing software as an enabler of customer solutions. Many of these solutions will come from the outside."



digital

A proprietary operating system holds its own

Digital Equipment Corp.'s marketing slogan, "Digital has it now," is a vast understatement in terms of the company's software strategy. Unlike the other major computer hardware vendors, DEC has had the "luxury" — in the words of Roger Heinen, corporate consulting engineer for software systems — of

running a single proprietary operating system, VMS, on all of its VAXs since 1978. As a result, "we don't need an SAA [IBM's Systems Application Architecture]," Heinen claims. "We're 10 years further in evolution" than the other vendors.

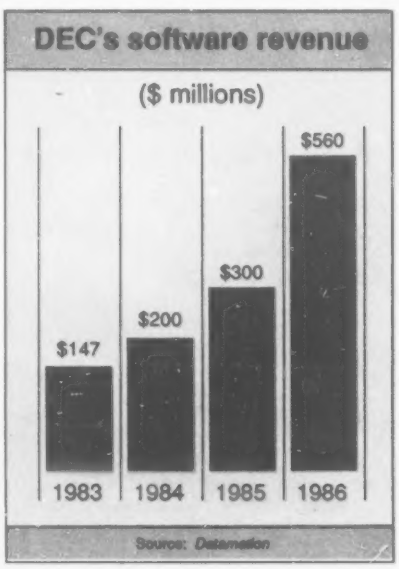
So, while other manufacturers are racing to make their lines more compatible and thus more attractive to independent software vendors and end users both, DEC's charge is to stay its tried and true course. In DEC's case, that is "to deliver complete information systems to customers based on VAX, VMS, OSI [Open Systems Interconnect], and DECNet," Heinen says, "as well as to integrate with other [companies' hardware and software] architectures."

Thanks to DEC's cross-line compatibility, market watchers say its cooperative marketing partnership (CMP) program is one of the most successful third-party software organizations in the industry. Currently, the only applications DEC develops and enhances itself are those common to all users, such as integrated office software like All-In-1.

DEC's central software organization, which employs over 2,000 people and operates primarily out of its Spit Brook development facility in Nashua, N.H., is organized vertically by applications marketing groups, and horizontally by industry marketing groups. Its application groups include office, laboratory, engineering, factory, and corporate MIS (management information systems); its industry groups include insurance, finance, banking, and such. The company's recent moves to add multiprocessing capabilities to VMS via its real-time VAXeln software package will give DEC a boost in several of these key areas, most notably factory and engineering, Heinen says.

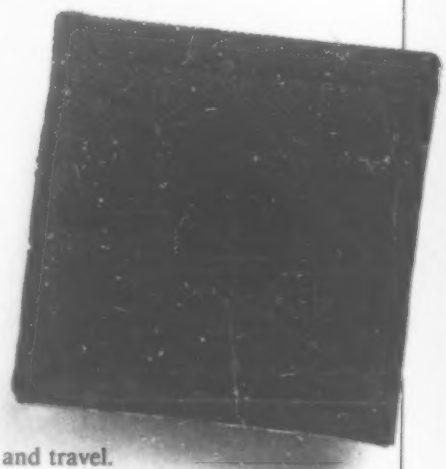
At the same time, DEC is working to establish and firm up its presence in other areas, including transaction processing, networking and desktop computing, Heinen says. It also is attempting to expand its offerings by ramping up marketing and sales of Ultrix, its Berkeley 4.2 based (but AT&T System V compatible) version of the Unix operating system. Analysts say DEC has placed undue emphasis on its proprietary VMS system at the expense of industry-standard Unix in order to lock in customers.

"We just need to have field service people ready and able to support the product," Heinen retorts. DEC has been striving to reach this point for two years; now its efforts are coming to fruition, he says. "Customers do understand the difference between VMS and Ultrix, and it's usually obvious which is the appropriate choice." With its DECWindows interface, however, users are able to run both operating systems simultaneously, he points out. In fact, "marketing the two products has been much easier than we ever imagined," Heinen claims.



UNISYS

Line-of-business focus aids in integration



It is not only incompatible Sperry and Burroughs hardware architectures that have plagued Unisys Corp. since its creation from the merger of the two companies in 1986. Equally, if not more so, the mishmash of operating systems, ranging from the proprietary 1100 OS to industry-standard Unix and MS/DOS, have proven difficult for Unisys to integrate. One factor which has worked in the company's favor from a software standpoint, however, is its line-of-business emphasis.

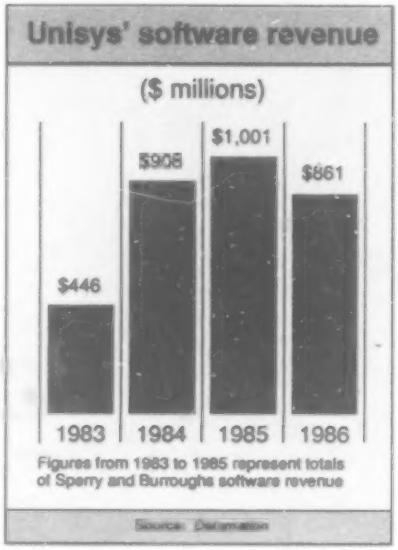
"Unisys has placed, indirectly, value on applications software by our commitment to a line-of-business focus," according to L.W. "Roy" Beers, vice president of corporate industry management for the Blue Bell, Pennsylvania-based corporate marketing services division. "This means a fully vertical commitment to providing every aspect of a solution to companies in those particular businesses." These lines of business include: commercial and industrial; finance; public sector including hospitals, schools and the like; and communications and travel.

Unisys develops and maintains the extremely complex applications software it offers in these areas. Some of its products include its Global Financial System, Police Information Management System, and Health Care Financial Management System, to name a few. "If R&D dollars spent is the measure, there's more activity at Unisys in internal [software] development," Beers acknowledges. "Many of these large sophisticated solutions are beyond the capabilties of many third parties."

"But from a number of products standpoint, the balance [between internal and third-party development] may be weighted the other way," he continues. Especially in so-called cross-industry applications — ac-

counting, for example — Unisys is relying more heavily on third parties to develop and support software for Unisys machines.

In order to make its hardware attractive to third-party software developers in an increasingly IBM/DEC-dominant world, Unisys is placing a lot of emphasis on "system independent software," in Beers' words. To a large extent, this means Unix. But it also includes the provision of sophisticated fourth-generation languages and tools — such as Unisys' Linc and Mapper development products — so that programmers can write software for one system and easily recompile it to run on another. "If you do applications development right and make software machine-independent, you don't need to worry about hardware platforms," Beers claims.



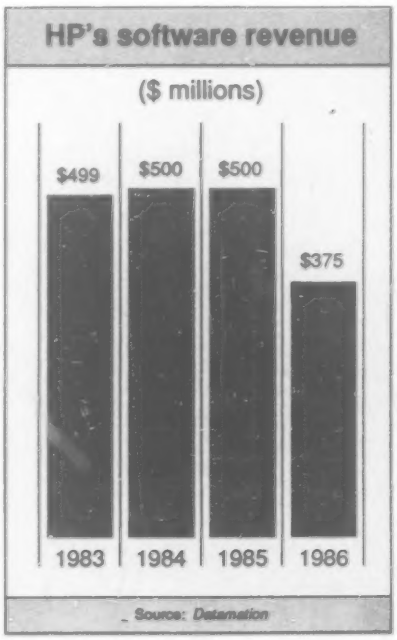
"For awhile, HP thought we could do a lot more in applications development ourselves," admits Robert Frankenberg, general manager for the business systems's Information Systems Group. "Now, the vast majority of applications come from third parties. We decided it was better to work with other companies, except in areas where we had the expertise."

"Sometimes, there is a problem in terms of our [HP-developed] offerings competing with theirs," adds William Parzybok, general manager of the engineering and manufacturing systems group. "We want it all, just like they want it all."

But, first with HP's introduction of its AT&T System V-based Unix system, known as HP-UX, and now with NewWave, HP is attempting to offer third-party developers access to more open platforms in order to increase the number and quality of applications available on HP hardware. "NewWave will provide third parties with the opportunity to substantially differentiate their applications from their competitors," claims Frankenberg.

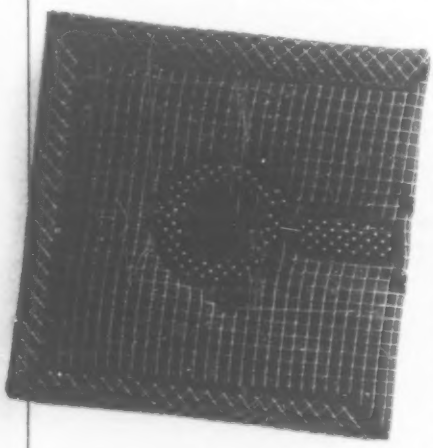
"We treat software as a technology, not a business," Frankenberg continues. "Complex user needs are now being satisfied better by software," than by hardware. NewWave and more third-party offerings will ensure that HP meets these needs, he says.

Foley is a Washington, D.C.-based business and technology writer



Riding the NewWave to compatible software environments

Hewlett-Packard Co.'s November announcement of its NewWave environment was the biggest software news to come from the Palo Alto, Calif., company in quite awhile. In the short run, NewWave may prove to be little more than a fancy marketing tool. But, as it is ported from HP's personal computers to its various technical workstations, and ultimately to HP's various minicomputers, it promises to bring cross-line compatibility equal to, if not greater than, that anticipated from IBM's Systems Application Architecture strategy.



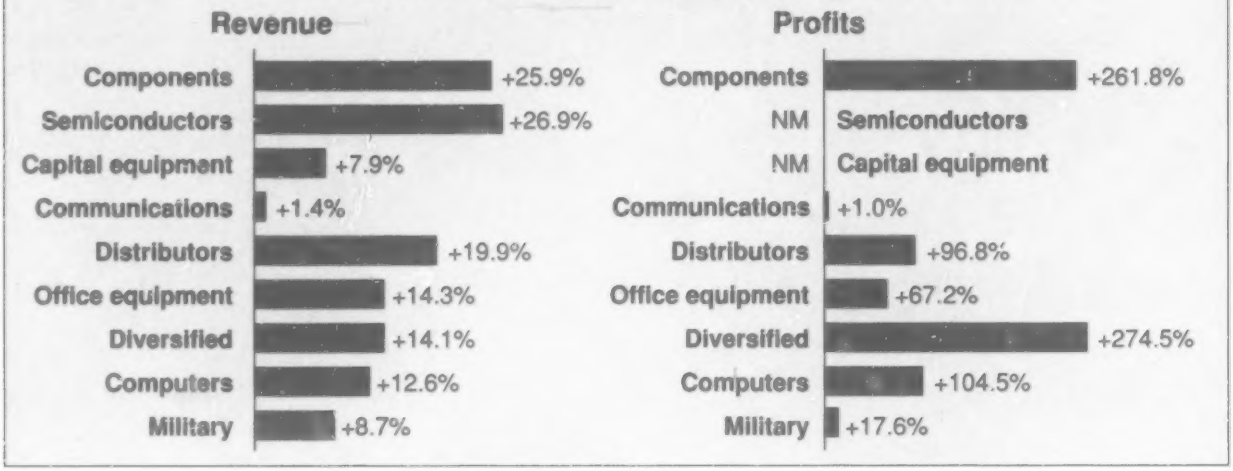
In brief, NewWave is a software-application environment, based on the emerging Microsoft Corp. Windows standard. It incorporates object-management technology, artificial intelligence principles, and a common graphics interface to allow users to access data and files seamlessly from multiple sources. NewWave is currently available to third parties, and will be shipped to end users sometime in the second half of this year.

Prior to NewWave's introduction, there was relatively little software synergy among HP's business, engineering and manufacturing systems sectors — the three HP areas responsible for developing, selling and supporting most of what is considered traditional computer hardware. The business sector is subdivided into four divisions: office and productivity; office systems; personal software; and workstations. Collectively, these concentrate on office applications such as electronic mail, document generation packages, communication software and so forth. Engineering and manufacturing, on the other hand, are more involved in supplying customized turnkey solutions in the areas of computer-aided engineering, design and manufacturing. Operating systems software for all three divisions tends to be handled by the respective hardware divisions.

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 4th quarter of 1986 to 4th quarter of 1987



	4th quarter figures				Year-to-date figures				
Components (other than semiconductors)	Revenue 4th quarter 1987 ($ millions)	Change from 1986	Profits 4th quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
AMP	$633.0	25.0%	$70.0	51.2%	$2,318.0	19.9%	$250.0	52.1%	Dec. 31
AVX	79.8	57.9%	4.6	NM	271.9	39.2%	15.8	NM	Dec. 31
Augat	80.9	25.5%	3.3	NM	313.2	20.3%	11.5	NM	Dec. 31
BRIntec	70.2	5.6%	2.1	40.2%	293.7	3.6%	5.9	-51.2%	Dec. 31
Kollmorgen	84.0	18.6%	1.1	NM	301.0	-5.7%	0.3	NM	Dec. 31
Molex	122.9	33.9%	14.3	50.6%	437.1	25.1%	50.2	29.2%	Dec. 31
Segment composite	**$1,070.80**	**25.9%**	**$95.40**	**261.8%**	**$3,934.90**	**17.8%**	**$333.70**	**81.8%**	
Semiconductors									
Advanced Micro Devices[1]	$262.5	32.8%	-$2.6	NM	$997.1	20.3%	-$48.1	NM	Dec. 31
Burr-Brown	38.5	34.6%	1.7	1,023.3%	140.5	24.6%	4.3	14.7%	Dec. 31
Intel	572.5	61.0%	95.5	NM	1,907.1	50.8%	248.1	NM	Dec. 31
LSI Logic	78.3	43.6%	5.8	237.2%	262.1	34.9%	11.3	194.2%	Dec. 31
Texas Instruments	1,534.7	14.9%	93.7	252.3%	5,594.5	12.5%	308.5	673.2%	Dec. 31
Western Digital	160.7	40.4%	8.2	-15.1%	563.1	50.8%	44.4	40.8%	Dec. 26
Segment composite	**$2,647.2**	**26.9%**	**$202.3**	**NM**	**$9,464.4**	**22.1%**	**$568.5**	**NM**	
Capital equipment									
Fluke	$51.5	0.7%	$2.9	10.4%	$206.7	-0.9%	$2.3	-80.3%	Dec. 25
GenRad	50.7	-5.4%	1.1	NM	193.8	9.4%	-37.0	NM	Jan. 2
Tektronix	318.6	-0.5%	4.8	-72.5%	1,388.9	2.7%	25.7	-53.4%	Nov. 14
Teradyne	96.1	13.0%	-11.2	NM	377.7	7.6%	-21.1	NM	Dec. 31
Varian	265.0	23.3%	-17.6	NM	1,033.0	15.6%	-4.1	NM	Jan. 1
Segment composite	**$781.9**	**7.9%**	**-$20.0**	**NM**	**$3,200.0**	**7.3%**	**-$34.3**	**NM**	
Communications									
Andrew	$54.5	11.9%	$2.7	16.9%	$229.0	15.7%	$4.2	-55.9%	Dec. 31
DSC Communications	79.6	6.8%	5.1	115.4%	312.4	2.8%	14.6	31.9%	Dec. 31
Dynatech	94.6	19.8%	6.1	-9.2%	347.0	17.3%	21.1	-15.0%	Dec. 31
General DataComm	44.2	-17.1%	-7.6	NM	192.6	1.1%	-8.2	NM	Dec. 31
Micom Systems	56.6	11.3%	1.9	10.5%	211.5	9.9%	9.3	275.7%	Dec. 31
Northern Telecom	1,300.0	0.0%	140.0	5.9%	4,900.0	11.4%	347.2	10.9%	Dec. 31
Segment composite	**$1,629.5**	**1.4%**	**$148.1**	**1.0%**	**$6,192.4**	**11.0%**	**$388.1**	**6.4%**	

[1] Includes Monolithic Memories Inc. since August 13, 1987 acquisition

NM = Not meaningful; company had a loss in the base year

(Continued)

Financial results of leading U.S. electronics companies

	4th quarter figures				Year-to-date figures				
Distributors	Revenue 4th quarter 1987 ($ millions)	Change from 1986	Profits 4th quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
Anthem Electronics	$56.9	39.9%	$1.9	322.1%	$196.9	48.8%	$5.0	76.0%	Dec. 31
Avnet	429.3	14.2%	12.9	180.4%	1,670.7	13.2%	37.3	94.3%	Jan. 1
Marshall Industries	101.3	52.0%	4.2	404.5%	340.3	26.4%	10.6	135.7%	Nov. 30
Pioneer-Standard	63.1	23.3%	1.3	229.6%	238.5	16.3%	4.4	385.7%	Dec. 31
Premier Industrial	127.7	11.3%	15.5	30.4%	486.8	9.7%	56.0	27.8%	Nov. 30
Segment composite	**$778.3**	**19.9%**	**$35.8**	**96.8%**	**$2,933.2**	**16.1%**	**$113.2**	**59.0%**	
Office equipment									
Diebold	$119.3	6.1%	$11.9	19.7%	$439.1	5.2%	$35.8	2.5%	Dec. 31
NCR	1,820.1	15.6%	161.4	20.4%	5,640.7	15.5%	419.3	24.6%	Dec. 31
Pitney Bowes	643.4	14.2%	67.9	26.0%	2,250.5	13.3%	199.4	20.1%	Dec. 31
Wang	784.7	17.3%	34.1	NM	3,047.6	14.2%	94.5	NM	Dec. 31
Xerox	4,200.0	13.5%	155.0	12.3%	14,900.0	15.5%	578.0	18.4%	Dec. 31
Segment composite	**$7,567.4**	**14.3%**	**$430.3**	**67.2%**	**$26,277.9**	**15.0%**	**$1,327.0**	**41.3%**	
Diversified									
General Instrument	$298.1	32.7%	$19.9	243.5%	$1,104.0	56.3%	$53.7	206.0%	Nov. 29
Gould	242.9	6.8%	8.7	58.2%	933.4	2.7%	25.0	-27.7%	Dec. 31
Harris	501.4	-6.1%	24.2	20.1%	2,223.3	6.0%	92.2	34.4%	Jan. 1
Honeywell	1,985.1	22.8%	86.1	NM	6,679.3	24.2%	253.7	1,866.7%	Dec. 31
Motorola	1,850.0	14.2%	102.0	61.9%	6,700.0	13.8%	308.0	58.8%	Dec. 31
Tandy	1,303.0	8.9%	130.8	27.8%	3,654.7	10.0%	289.0	27.9%	Dec. 31
Segment composite	**$6,180.5**	**14.1%**	**$371.6**	**274.5%**	**$21,294.8**	**16.3%**	**$1,021.6**	**84.6%**	
Computers, peripherals and software									
Amdahl	$482.9	43.4%	$53.0	79.1%	$1,505.2	55.8%	$146.0	249.0%	Dec. 25
Apollo	163.0	34.8%	10.5	99.4%	553.7	41.4%	21.7	132.5%	Dec. 31
Apple	1,042.4	57.4%	121.4	107.6%	3,041.3	49.1%	280.3	80.3%	Jan. 1
Control Data	927.5	2.6%	17.5	NM	3,366.5	0.6%	25.0	NM	Dec. 31
Compaq	432.1	131.2%	49.0	201.8%	1,224.1	95.8%	136.3	217.7%	Dec. 31
Cray Research	163.6	18.4%	34.1	46.1%	687.3	15.2%	147.1	17.4%	Dec. 31
Data General	342.9	9.4%	12.4	275.8%	1,304.0	1.3%	-73.7	NM	Dec. 26
Digital Equipment	2,782.3	22.5%	329.5	22.1%	10,391.1	23.5%	1,284.3	49.1%	Dec. 31
Genicom	87.7	103.4%	3.3	31.9%	302.2	91.9%	10.5	22.4%	Dec. 31
IBM	18,011.0	6.3%	2,087.0	50.1%	54,217.0	5.8%	5,258.0	9.8%	Dec. 31
Intergraph	195.3	24.1%	24.7	26.7%	641.1	5.8%	69.9	-0.7%	Dec. 31
Lotus Development	115.6	41.3%	22.9	46.8%	395.6	39.8%	72.0	49.1%	Dec. 31
Mentor Graphics	61.4	24.5%	6.1	55.9%	221.8	27.8%	20.3	84.8%	Dec. 31
Micropolis	80.4	55.2%	7.2	39.7%	288.3	35.2%	27.2	49.3%	Dec. 25
Microsoft	155.9	92.5%	35.3	79.4%	456.7	75.5%	92.9	61.2%	Dec. 31
Miniscribe	116.2	119.7%	9.1	42.3%	362.5	96.1%	31.1	37.1%	Dec. 31
Prime	227.0	-5.4%	21.3	50.5%	960.9	11.7%	64.8	38.0%	Dec. 31
Seagate Technology	332.5	32.0%	22.8	-39.3%	1,075.7	51.6%	115.3	27.6%	Dec. 31
Storage Technology	208.2	13.0%	5.6	134.3%	750.0	7.8%	19.0	12.8%	Dec. 25
Stratus Computer	55.2	56.0%	6.5	77.0%	184.2	47.8%	19.4	43.5%	Jan. 3
Sun Microsystems	235.1	101.8%	14.0	64.1%	754.4	120.1%	48.0	99.1%	Dec. 25
Unisys	2,798.9	10.4%	216.9	NM	9,712.9	30.7%	578.0	NM	Dec. 31
Segment composite	**$29,017.1**	**12.6%**	**$3,110.2**	**104.5%**	**$92,396.2**	**14.1%**	**$8,393.4**	**36.5%**	
Military									
E-Systems	$315.6	4.8%	$17.7	19.0%	$1,227.2	8.1%	$60.4	-1.9%	Dec. 31
GM Hughes	2,700.0	3.8%	146.0	36.4%	10,500.0	1.0%	670.0	12.8%	Dec. 31
Logicon	56.7	15.4%	2.5	11.6%	211.5	3.4%	6.6	-29.6%	Dec. 31
Loral[1]	373.6	126.2%	18.7	40.0%	1,028.3	116.4%	51.7	30.6%	Dec. 31
Raytheon	2,137.0	4.7%	117.9	18.4%	7,659.0	4.8%	445.1	13.2%	Dec. 31
Singer	563.4	13.7%	10.6	-64.7%	1,902.7	10.3%	23.4	-60.0%	Dec. 31
Watkins-Johnson	69.6	7.9%	4.9	36.2%	264.3	3.5%	17.8	3.2%	Dec. 31
Segment composite	**$6,215.9**	**8.7%**	**$318.3**	**17.6%**	**$22,793.0**	**6.0%**	**$1,274.9**	**8.7%**	

[1] 1987 results include the results of Goodyear Aerospace Corp. (acquired on March 13, 1987) now called Loral Systems Group

NM = Not meaningful: company had a loss in the base year

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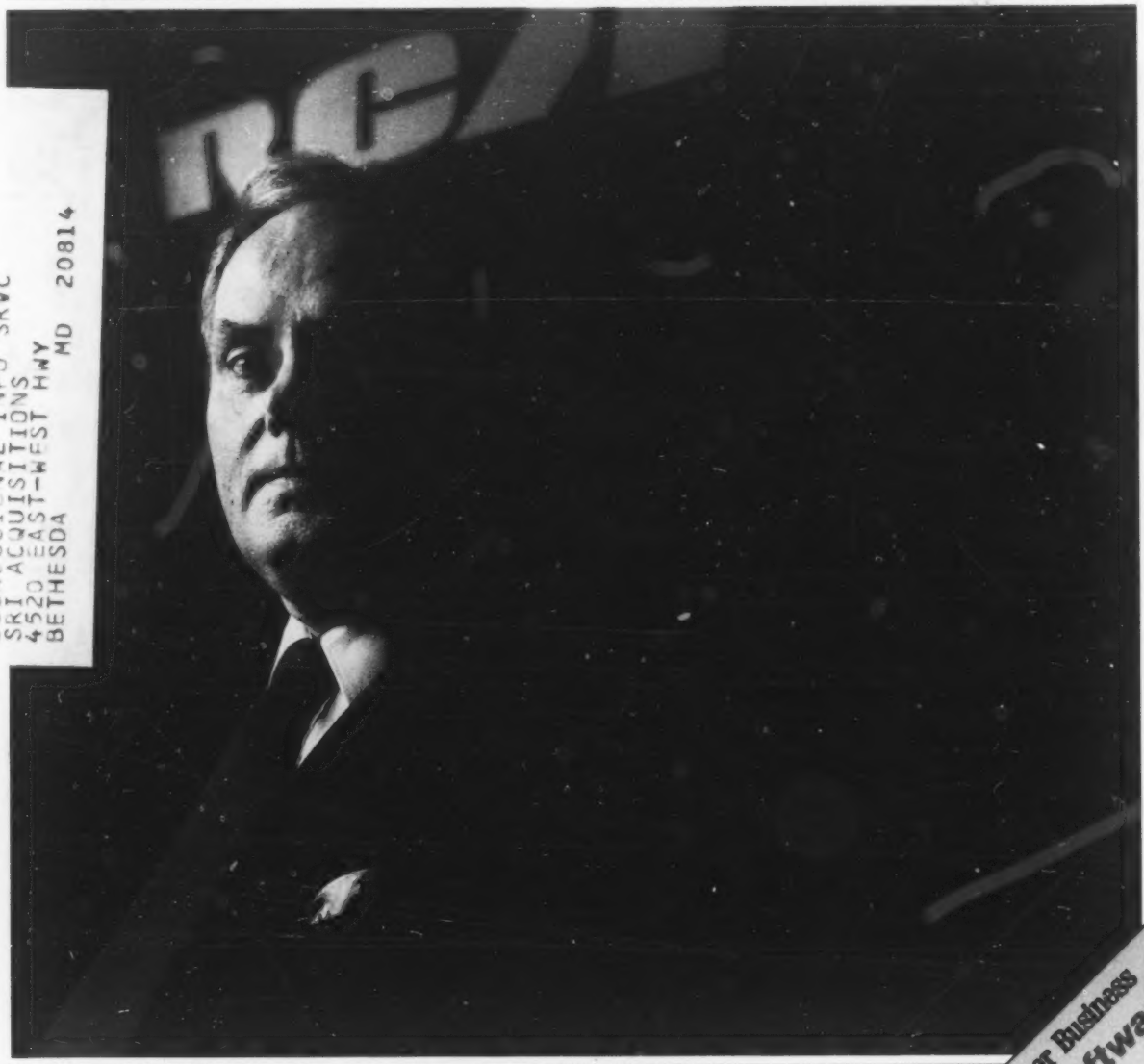
Hot auto sales put Europe's IC makers in the fast lane PAGE 24



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Cover photo/Jonathan Levine

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BPA ABP

Semiconductors continue to lead the recovery

There's plenty of good news to come. Profits are up, with a little help from the tax man

Sales records are made to be broken in fourth quarters, when companies push shipments out the door. So it shouldn't surprise anyone to learn that the ELECTRONIC BUSINESS Index for revenue, a composite of sales by 16 U.S.-based electronics companies deemed representative of this country's electronics industry, hit a record during the last quarter of 1987. Since most companies are on calendar years, our revenue index surges with the winter solstice. Last year was true to form; revenue for the last quarter was more than 11% higher than for the last quarter of 1986. That increase was enough to push revenue up by almost the same percentage for the whole year.

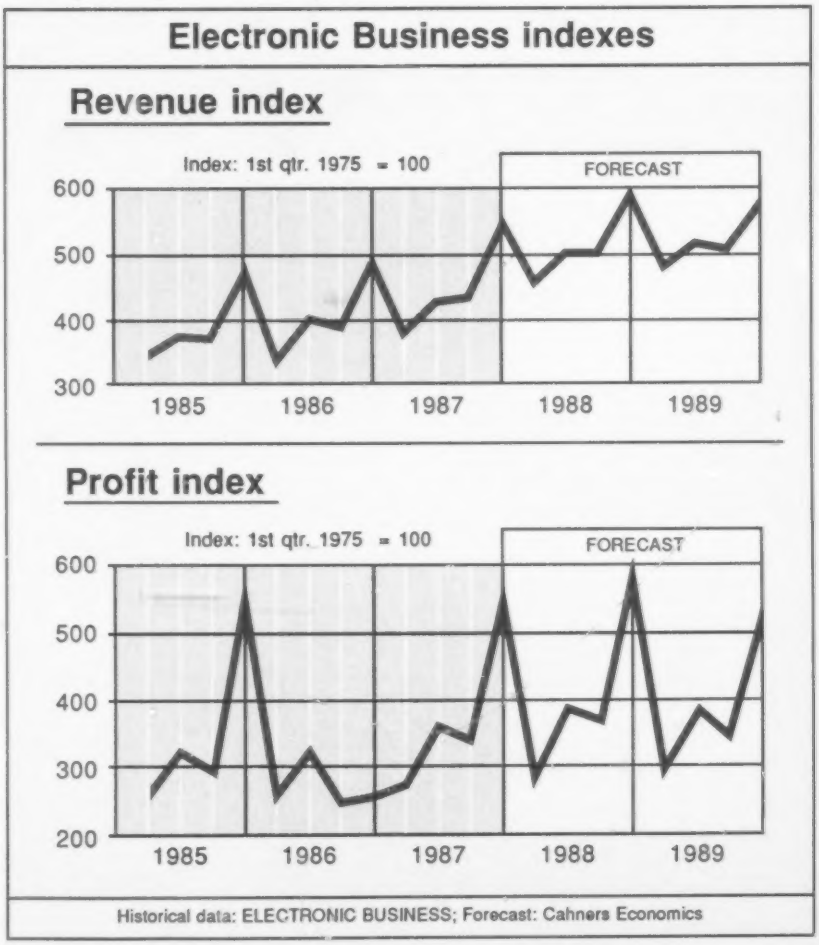
What was surprising was the strength of the profits' recovery in that quarter. Indeed, we had predicted that companies were going to emphasize profits in 1987 [see "Nursing the bottom line back to health," July 1, 1987, p17], but we had not expected the fourth quarter profits index to nearly break records. In fact, it almost tied the previous record, set in the last quarter of 1985. And these profits did set a new record in growth. Profits in the last quarter of 1987 more than doubled those of the year-earlier quarter. For the whole year, profits were 40% ahead of 1986, our index's largest annual increase ever.

This strong showing in last year's fourth quarter came from an unusual combination of forces from both ends of the electronics industry's economic cycle. At the leading end are the components manufacturers, primarily the chip makers, for whom the recovery is in full bloom. They were first in cutting costs; now that they sell more, more of their sales go to the bottom line. At the trailing end are the manufacturers of large computers and capital equipment whose sales have not recovered yet, but who are still cutting costs to stay in the black.

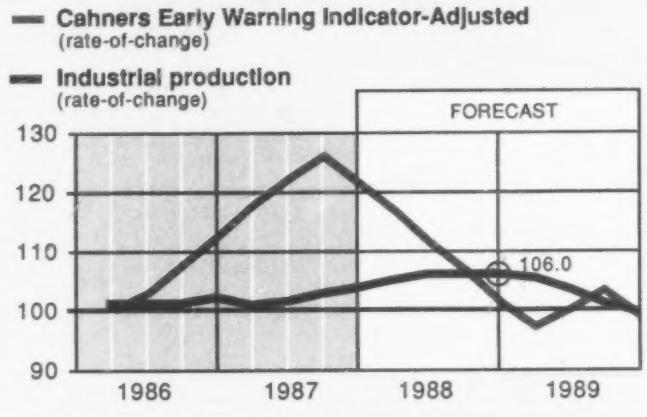
For example, sales by chip maker Intel Corp. were 61% ahead of the last quarter of 1986, and the company's revenue is well on its way to exceeding $2 billion this year. Profits swung from deep red to solid black. On the other hand, IBM is still waiting for the recovery to lift its fortunes. Big Blue's bland performance at the cash register in the fourth quarter — up a meager 6% over 1986 — was accompanied by a dramatic 50% increase at the bottom line. Granted, IBM's profits got a little help from Uncle Sam because taxes in that quarter were lower than in the year before. But those profits still would have been up almost 30%, even without the tax reduction.

Senior economist Elizabeth Baatz of Cahners Economics forecasts that our revenue index will be up 14% this year, but that growth will come almost to a halt in the third quarter of next year. If so, companies at the trailing end of the economic cycle may not have many rich quarters ahead. But then, they did not have many poor ones during the industry's slowdown from 1985 to 1986.

ALBERTO SOCOLOVSKY



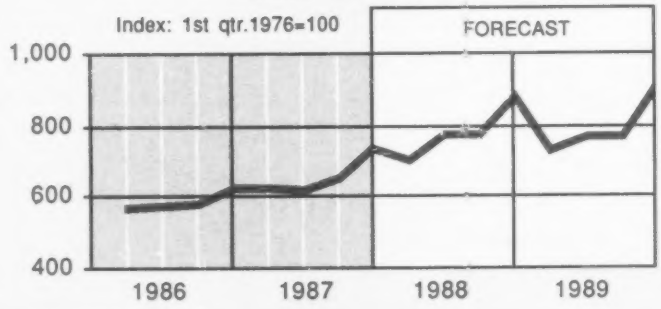
Economic indicators



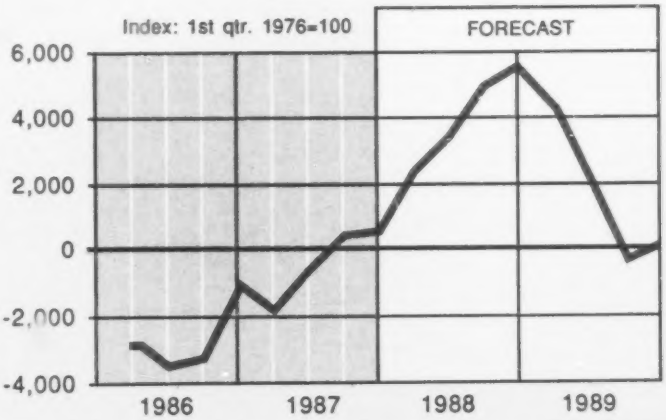
Historical data: Federal Reserve Board; Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. During 1987's third quarter, output rose 2.1% from the prior quarter and was up 3.1% year-to-date compared with the previous year. This slow and steady growth is expected to continue until this summer. Production is expected to rebound after a year and a half of sluggish growth, pushing production up 6% this year. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar, inventory replenishment and growth in business equipment investment.

The Cahners Early Warning Indicator (CEWI) has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle, with the next business peak in August of 1988. The CEWI is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2), deflated by the Consumer Price Index. The CEWI has proven to be an excellent tool in forecasting the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That change over a 12-month period can be determined by comparison with the line at 100. For example, the 106 level forecasts using the CEWI for the end of this year indicates that the average for all of 1988 should be 6% above 1987.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St. Newton, Mass. 02158.

ATE revenue and profit

Fourth quarter 1987 revenue for manufacturers of automatic test equipment rose 12.3% above the prior quarter and increased by an even stronger 17.9% over the year-ago quarter. This strong final quarter boosted annual revenue 11.8% to $1.79 billion. This year, the demand from computer and semiconductor manufacturers for automatic test equipment shows further signs of strengthening. Revenue is expected to rise a sharp 18% this year, followed by a much slower 1.7% increase in 1989. ATE manufacturers returned to profitability during the second half of 1987. Not since the second quarter of 1985 has the ATE index shown positive earnings. Profits are expected to show healthy increases for the rest of 1987 through 1988, with a slowdown forecast in mid-1989.

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SEMICONDUCTORS

The rise and fall of Britain's IC empire

A merger with Ferranti makes Plessey the largest chip maker in England, but Britain still lags the U.S. and Japan

Chadderton is a grim and grey factory suburb on the outskirts of Manchester in the north of England. Its aging buildings contrast with Silicon Valley's spanking modern plants. But this decaying monument to Britain's 2-centuries-old Industrial Revolution is the birthplace of one of the most successful high-tech devices of the 1980s — the gate array.

Gate arrays — basically, semicustom chips — were first devised in a converted textile mill at Chadderton by Ferranti Plc a dozen years ago. The devices have since become one of the fastest-growing sectors of the semiconductor industry.

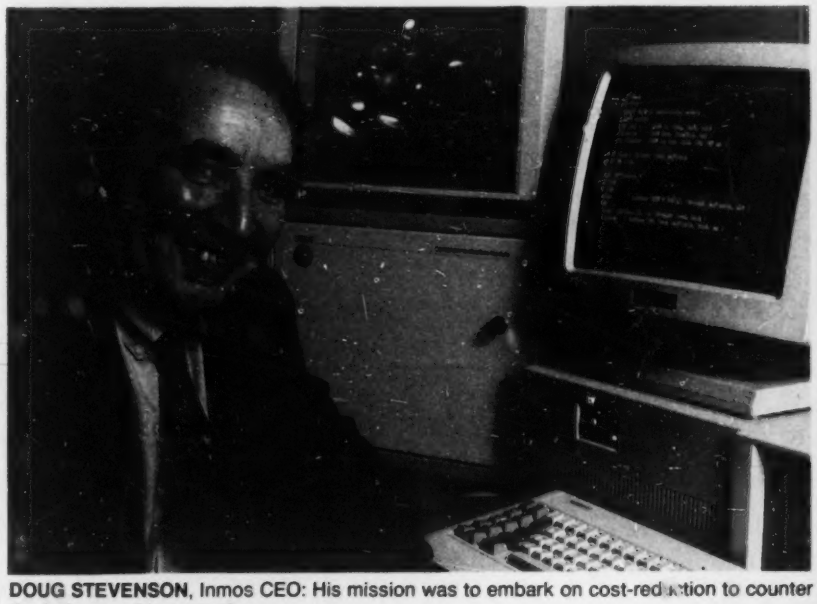
But Ferranti's reluctance to dirty its fingernails with aggressive marketing robbed it of the fruits of imaginative research. Over the years, the British firm has captured only a small part of worldwide gate array sales. Motorola Inc. grabbed Ferranti's leadership in the mid-1980s. Since then, Fujitsu Ltd., LSI Logic Corp., NEC Corp. and others have snatched significant shares of this increasingly profitable business.

Ironically, however, while British electronics firms are not expanding as fast as their rivals, their profit record is the envy of the industry at large. Britain's General Electric Co. and The Plessey Company Plc have been registering returns on sales as high as 10%, putting them well among the world leaders.

However, British chip makers have earned these profits, not in the hurly burly of the international marketplace but in the snug environment of British government defense contracts and equipment orders from British Telecom. Not a single British name figures among the world's top 10 electronics firms.

Accountants and lawyers

That absence underscores the shortage of business talent in Britain. Surveys show that only about one-third of Britain's top executives have



DOUG STEVENSON, Inmos CEO: His mission was to embark on cost-reduction to counter the industry-wide recession

The British semiconductor industry trails the rest of Europe

Source: Dataquest Ltd.

a marketing background. "Our companies are managed by accountants or by lawyers," says Peter van Cuylenberg, the British managing director of Texas Instruments Inc.'s unit in Britain. Business schools, a source of expertise in the United States, play only a minor role in the British environment.

The fast expansion of Britain's domestic telecommunications market explains its healthy sales charts for semiconductors. But most of these come from Japanese and U.S. suppliers. Jan Calen, Motorola Semiconductors' European director of marketing, predicts that the British chip market, which grew by 8.2% last year, will increase by 10.1% in 1988 and reach $1.25 billion (at an exchange rate of $1.70=£1). In Europe, only Italy, starting from a lower base, outstrips this rate.

Calen says: "The British market is driven by communications upsurge, the the best growth segment." According to the Motorola manager, Britain has maintained a steady 18% share of European semiconductor sales for the past two years. This places it behind Europe's biggest chip consumer, West Germany, whose share is 32% but ahead of France's 16%.

However, British firms manufactured less than 50% of the $750 million output of Britain's semiconductor plants in 1986. The bulk of these chips were made by Philips and Texas Instruments in England and by National Semiconductor Corp., NEC and Motorola in Scotland. Digital Equipment Corp. is also preparing a Scottish wafer fab.

Motorola is currently gearing up to make 1-megabit dynamic random access memories at East Kilbride, the only plant outside the United States that it has earmarked to manufacture its latest leading-edge product. Barry Waite, general program manager at the Scottish plant, says: "We high-speed CMOS process and will begin producing at the end of 1988. We're very pleased that we have been chosen as our corporation's leading-edge facility."

Neverthless, Britain continues to lag the United States and Japan in semiconductor manufacturing, as it clings to its traditionally strong position in smokestack industries at the expense of innovation. Although Britain still has a $3.4 billion trading surplus in mechanical engineering, it has slipped from rough equilibrium in electronics in 1970 to a 1986 deficit of $3.4 billion.

British designers might again surprise the world with a new device as revolutionary as the gate array. But could Britain's marketing managers sell it? Ferranti, for example, which last year acquired International Signal and Control, an American defense contractor, still survives as a manufacturer of defense electronics, computers and instrumentation. But it brought down the curtain in November on its venture into semiconductors.

Britain's industrialists and London's financiers regard the chip-making industry as highly risky and too costly

Ferranti's chip business was bought for a meager $56 million by Plessey, whose acquisitions include Stromberg Carlson, the U.S. telecommunications manufacturer. But Plessey was rebuffed by the U.S. Defense Department recently when it tried to take over Harris Corp.

Plessey-Ferranti merger

The new venture with Ferranti is likely to push Plessey's revenue from semiconductors up to $220 million this year and bring it into the top 30 manufacturers worldwide. Thanks to this partnership, Plessey today ranks No. 1 in Europe and No. 6 across the globe in gate arrays.

Jim Beveridge, Director of the European Components Group at Dataquest Ltd., the London-based arm of the San Jose, Calif., electronics market research firm, says: "The merger is fundamentally sound. Britain's semiconductor firms are too small to be viable. They need to cut costs and bring their product lines together."

Ferranti's recently developed capability in using standard cell technology for mixed digital and linear gate arrays is hailed by users as unsurpassed. "We are getting rid of overlap in our product families," says Doug Dunn, managing director of Plessey Semiconductors Ltd. "Now we can derive the benefits of merging our research and development, marketing and design resources."

However, Britain has yet to learn the moral of the Ferranti fable of missed opportunities. The British semiconductor industry is the most fragmented in Europe. Across the English Channel, continental Europe's patchwork of manufacturers have been faster to marshal its own dispersed resources. West Germany's Siemens AG and N.V. Philips GL of the Netherlands have joined forces in the much-vaunted Megaproject to devise powerful memory chips. The leading Italian and French chip makers have allied under the banner of SGS Thomson Microelectronics.

In swallowing Ferranti's chip activities, Plessey has recognized that survival is becoming increasingly precarious for small producers. But Plessey's own niche-based strategy, based on its success with application-

specific integrated circuits, could prove risky if Japanese and U.S. groups use their muscle to turn these chips into commodity products. Comments Iann Barron, chief strategic officer at Inmos International Plc, an imaginative but financially rent British chip firm which is now up for sale: "As the level of integration increases, most ASICs will combine microprocessors and memory. So success will depend on access to microprocessor and memory technology."

However, Plessey is turning a deaf ear to industry watchers who urge it to follow its U.S., Japanese and European competitors into the commodity chip market. John Clark, Plessey's chairman, says: "For 20 years, we have studiously avoided going in for commodity silicon. Massive investment and competitive pricing mean you are chasing your own tail."

Clark adds: "Plessey does not see itself as a national champion redressing Britain's trade imbalance in commodity chips. It's too late for Britain to get into that business. The market for ASICs and USICs [user-specific integrated circuits] is our last chance."

This argument is challenged in a recent report on the British integrated circuit industry prepared for the Department of Trade and Industry by Ian Mackintosh, a consultant specializing in high technology issues. Apart from Plessey, Britain's semiconductor industry is composed of the chip division of STC Plc and Inmos, a subsidiary of the Thorn-EMI electronics group and creator of the "transputer." "What we need is to assemble a chip industry with sales of about $340 million," says Mackintosh. "Only then, will Britain stand a chance in world markets."

Mackintosh's thesis is challenged by many British industrialists and policymakers, including financiers in the city of London. They regard the chip making industry as highly risky and too costly. The British business community also points out that the users of chips account for only a small part of British manufacturing.

Unfortunately, the critics are making a valid point. In 1986, output in Britain of information technology products was worth $20 billion, only 6.5% of total manufactured items. That compares with 20% for information technology-based goods in the United States and 12.5% in Japan. "Growth of the information technology sector is firmly linked with the growth of the semiconductor industry. While the U.S. and Japan have forged ahead in both IT and chips, Britain, like its European neighbors, has lagged behind," says Mackintosh.

The antidumping agreement between the United States and Japan has raised prices of memory chips for European systems makers. This makes it more important than before for British users to have access to off-the-shelf chips from local suppliers. British systems firms are also handicapped because they lack the close contact with semiconductor designers which are so valuable to their U.S. and Japanese competitors.

But the Japanese can recognize a good British chip when they see one. Shortly before its semiconductor operations were merged with those of Plessey, Ferranti was asked by Canon, the photocopier and camera maker, to supply high speed chips for its next generation of facsimile machines. Keizo Yamaji, Canon's vice president says: "We're working with the British firm because no Japanese supplier can provide a suitable chip."

JACK GEE

Transputer: Finding a niche for a new 32-bit chip

Mergers have become the top priority for Britain's semiconductor manufacturers as they watch their competitors in the United States and continental Europe ally to preserve and conquer markets. Inmos International Plc has captured the imagination of electronics designers with the "transputer," a 32-bit microprocessor which combines all the functions of a computer. But this subsidiary of Britain's Thorn-EMI Plc electronics group is feeling even lonelier now that The Plessey Company Plc has taken over Ferranti Plc's chip making activities.

Doug Stevenson joined Inmos as chief executive three years ago from ITT Corp., where he headed microelectronics operations. "I learned a lot from Harold Geneen, the ITT president, about tight budgetary control and planning procedures," Stevenson says.

His mission at Inmos was to embark on cost-reduction programs to counter the industry-wide recession and launch the company's first transputer products. This meant switching volume production of its high performance static random access memories from a facility in the U.S.' Colorado Springs, to Newport, Wales.

Last December, Inmos closed its private plant in Colorado Springs, with the loss of about 300 jobs. Stevenson commented: "We will continue to maintain a strong presence in the U.S. with a nationwide sales organization, customer support, and a test operation delivering military products to the U.S. defense industry."

Iann Barron, Inmos' chief strategic officer, spends about half the year at the U.S. headquarters. "This makes sense," he says. "The U.S. represents 70% of our business."

Closeness to the U.S. market enabled Inmos to score a major success last year. IBM incorporated a variation of the transputer in its new Personal System/2 family of personal computers. The chip is a "color look-up table," an electronic palette which makes it possible to "paint" any point on the PC's video screen in any one of 296 different shades.

But Inmos will remain mired in debt unless it can capture more design wins like the IBM contract, which is believed to be worth more than $20 million dollars up to the end of this year. "Crisis time has arrived for Inmos," says Jim Beveridge, director of Dataquest's European Components Group. "They could be snapped up by a buyer at any moment."

Stevenson comments: "It's not just a question of cash but of getting the right partner. We need to sign up with an electronic group that has the financial muscle to invest in research and development and the ability to put our chips into its products." □

POWER SUPPLIES

There's plenty of power in the power supply industry

Analysts and vendors agree that the merchant side of the market will grow, thanks in part to personal computers

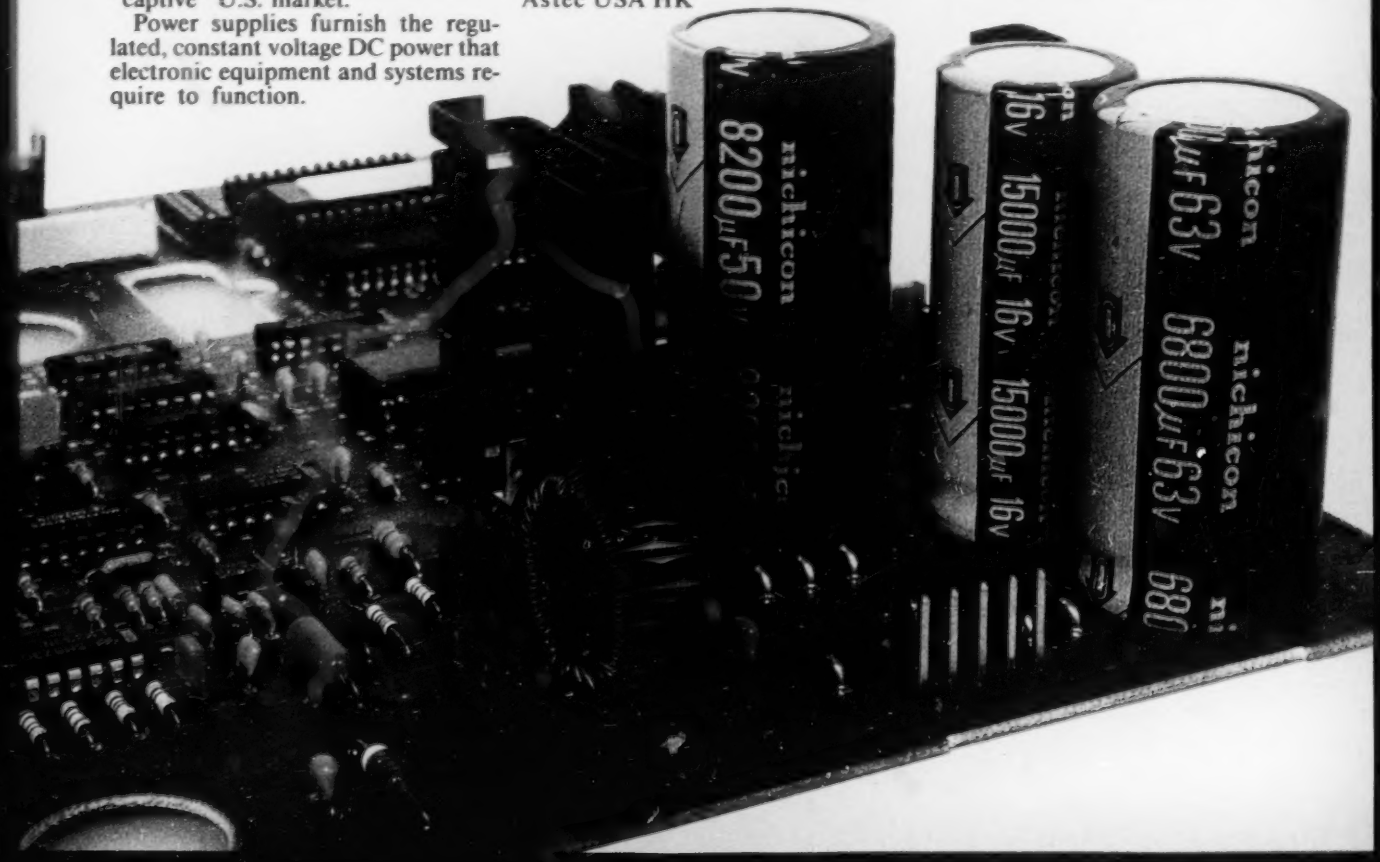
By Lin Sun

About 25% of the area in the IBM ProPrinter's single printed circuit board is taken up by a power supply. Its electrolytic capacitors, coils, heat sinks and switching power transistors tower above the rest of the board's components, a prominence probably matched by their cost. Big Blue builds 3,000 ProPrinters a day, and that is also the number of switching power supplies its popular mass produced, low-cost printer adds daily to the "captive" U.S. market.

Power supplies furnish the regulated, constant voltage DC power that electronic equipment and systems require to function.

More than two-thirds of the dollar value of supplies consumed in the United States this year will be captive, according to Mohan Mankikar, president of Micro-Tech Consultants in San Francisco. Like IBM, AT&T and Digital Equipment Corp., many makers of big systems build their own supplies. But, for small systems such as personal computers, which require low power, low-cost supplies, most companies follow the example of Apple Computer Inc., which buys many of its supplies from Hong Kong-based Astec USA HK Ltd. Thus, Mankikar expects the captive share of the U.S. market to erode slowly, down to 62% by 1992.

Small systems are also driving up the market for switching power supplies — which efficiently regulate the DC output voltage by switching the AC input on and off at high frequency. Mankikar estimates that switchers already account for more than half of the market, and that their share will grow at the expense of linear power supplies. (Linears regulate by dissipating excess power. Thus,



they are less efficient than switchers, but supply a cleaner DC.) The third type of power supplies — DC to DC converters — will also grow and increase share, forecasts Mankikar, but at a rate much slower than that for switchers.

There's no single engine

But figuring out which way the market is heading is difficult, comments Irving Gutman, vice president for marketing and sales at Lambda Group of Veeco Instruments Inc. in Melville, N.Y. Lambda is the largest merchant vendor of power supplies worldwide. That's because power supplies are an attachment to all kinds of computers, telecommunications and electronic equipment. As such, says Gutman, there is no single "engine" in the United States which can drive the whole market. Power supply companies are wholly dependent on the applications in the markets their customers serve.

That's why Gutman and his colleagues in the industry keep a careful watch on the overall economy. "The Wall Street [October crash] has had a dampening effect on the economy," concedes Edward Schneider, president of Computer Products Inc., a leading power supply vendor in Pompano Beach, Fla. Sales rose about 5% last year and orders were up 10%. "But," he says, "the market is growing, and the outlook is encouraging. These problems in the [financial] markets have got to have some unfavorable impact on business, but we haven't seen it yet, and we're far enough down [the manufacturing chain] that we might not feel it for some time."

Mankikar has trimmed 10% off the dollar projections he had made a year ago for the U.S. market, but for a reason totally unrelated to the market crash. "Most of the growth is at the low end," he explains. "That's why companies like Zenith Electronics, which supply the PC clone makers, have grown faster than others, such as Powertec."

Merrill Simon, a board member and consultant for L H Research Inc., a manufacturer of switching power supplies in Tustin, Calif., points out that an upturn in the market may not necessarily mean more business for U.S. companies. "If more power supplies are sold in the U.S. market in 1988," he says, "the issue is: how many of those are going to be imported?"

To compete with the imported supplies, particularly in the low-power range, for personal computer applications, U.S. companies are moving some of their own manufacturing offshore. Computer Products has a 750-worker plant in Hong Kong, and ACDC Electronics, a subsidiary of Emerson Electric Corp., assembles supplies in Mexico. But the competitive advantage of manufacturing offshore is less important for higher power, lower volume units, typically with outputs of over 200 watts.

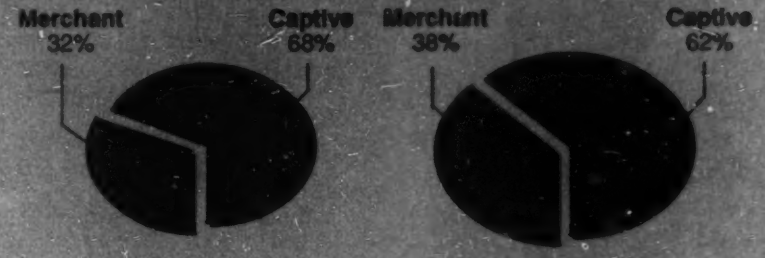
As a result, many U.S. companies concentrate on quality, reliability, service and technology, rather than on pricing issues. "Emphasis on quality has become important and will continue in 1988," says Eugene Zuch, director for corporate marketing at Computer Products. Bruce Hamilton, vice president for marketing at ACDC Electronics, says the interest is in increasing power density and efficiency for the larger supplies. One of the approaches ACDC and others

U.S. consumption of power supplies

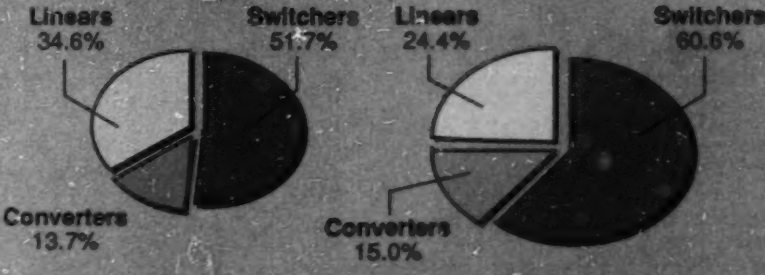
Total 1987 market $5.228 billion

Total 1992 market $7.496 billion

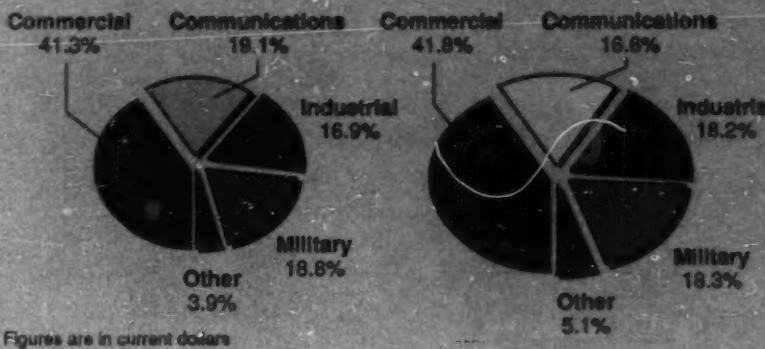
Market by type of manufacturer



Market by type of power supply

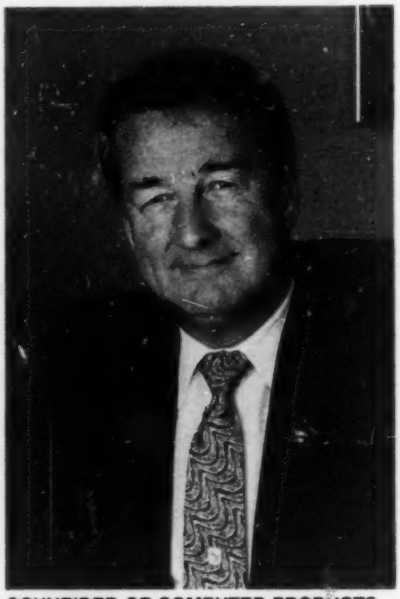


Market by type of application



Figures are in current dollars

Source: Micro-Tech Consultants



SCHNEIDER OF COMPUTER PRODUCTS remains optimistic about the year ahead

are exploring is to use resonant conversion technology (RCT), which allows a switching supply to operate at a higher frequency and thus increases efficiency and reduces the weight of the switcher's magnetic components.

Lambda boasts one of the broadest product lines in the industry, aimed squarely at the medium and higher ends of the original equipment manufacturers' markets. And Computer Products has spent a great deal of time and energy honing its distribution network, which includes major industrial electronics distributors such as Anthem Electronics, Bell Industries, Marshall Industries and Schweber Electronics.

To differentiate themselves from foreign suppliers, U.S. manufacturers are also emphasizing their semicustom capabilities. Although off-the-shelf products continue to occupy the bulk of the market, a large portion of the standardized segment involves modified units — that is, standard products which can meet specific customer applications. Also, as Zuch of Computer Products points out, custom supplies cannot be ignored, if that's what the customer wants — even if standard products are easier to manufacture and service.

Indeed, many customers demand custom supplies. But they usually take 17 to 18 weeks to deliver, according to Roger Lund, product manager for distributor Marshall Industries in El Monte, Calif. Lund notes that distributors now carry a broad range of off-the-shelf power supplies.

Even manufacturers like L H Research, which specializes in custom supplies, candidly admit they wish some customers would seek standard solutions. Simon explains that, even within one product line, each customized model requires qualification approval from the pertinent regulatory agencies such as the Underwriters' Laboratories, the Canadian Standards Association and the German VDE. Even minor changes increase the expense. "You need a huge engineering department" to handle modifications, Simon says. "It is a very unhealthy market trend." □

Top merchant power supply makers

1987 sales ($ millions)

	All power supplies		Switchers only	
	Worldwide	U.S.	Worldwide	U.S.
Lambda Electronics	$150	$90	$117	$61
Shindengen	120	—	69	—
Astec	100	60	100	60
Zenith Electronics	92	77	92	77
Computer Products	85	71.2	47	42.7
Emerson Electric	75	72.5	62.5	60.5
CEAG	70	20-25	50	20-25
ITT Power Systems	60-65	60-65	58	58
Low & Bonar	50-55	30-35	25-30	15-20
Power-One	52	50	15-20	15-20

Source: Micro-Tech Consultants

Essential computer etiquette: Don't interrupt

The rush to make sure that computers get the electrical power they need has led to healthy growth for the uninterruptible power supply (UPS) industry.

"In the long run, the power protection problem will only get more severe — computers are getting faster and their geometries smaller, making them more affected by the quality of power," says John Sullivan, a power consultant in Half Moon Bay, Calif. "But keep in mind that the power is no worse than it ever was. People are just more aware of it."

Sullivan projects that the UPS sector is set to average 20% annual growth in the United States, up from $531 million in 1986 to $1.3 billion in 1991.

An uninterruptible power supply is essentially a battery that stands between the line power and an important piece of equipment, usually a computer. The computer runs off the battery, and the battery is constantly recharged by the line power. If the power fails, the computer won't notice until the 10 minutes or so it takes to drain the battery — long enough for its operators to take emergency action.

Smaller systems are generally solid state, and the current technical trend is a move away from silicon-controlled rectifiers (thyristors) to power transistors.

Systems for the PC level are generally "standby power supplies" (SPS) — they don't power the equipment full time, but only switch in when the line power fails. This makes them cheaper, but they have to be able to supply full power within four milliseconds to be sure the computer won't notice anything.

To supply that performance is no longer particularly difficult, notes Paul Royalty, marketing manager for UPS/SPS maker Topaz Inc. in San Diego, Calif. "All you need is a transformer, a battery, and a printed circuit board," he says. "The circuitry is not very complex." Topaz expects its sales to grow 18% this year.

Adds the Topaz executive: "Four years ago we had about 17 major competitors. Now there are more than 100, representing every garage shop you can imagine, mostly entering at the low end with SPS sys-

PERIPHERALS

Micropolis: Slower growth but a bigger market

As the lines between end markets blur, this disk drive maker expands its product offering and enters new markets

By Bruce C.P. Rayner

Micropolis Corp. has a knack for being in the right place at the right time with the right product. The Chatsworth, Calif., maker of 5.25-inch Winchester disk drives has managed to capture sizable market share in the 85 megabyte and 170 megabyte drive market in the past few years. Now, it intends to use its production and marketing savvy to dominate in the 380MB business. But as 1988 wears on, and the disk drive industry lurches toward maturity, Micropolis is starting to rethink its focus. For the 11-year-old company, it is time to distribute its eggs into more than one basket.

In Micropolis' boardroom, 1988 will be remembered as the year of diversification. And if all goes according to plan, 1989 will see this strategy bear fruit. The $280 million company is developing products that bridge the gap between its traditional market — the professional workstation — and the markets on either side: personal computers and superminis.

In the past, Micropolis has succeeded with a very focused approach to its market. It would let the niche players trailblaze along the leading edge of design and manufacturing, then hop into the fray about three to six months down the line. That way, it avoids major debugging headaches, but keeps visibility on the all-important "window of opportunity." Products are designed and developed in its Chatsworth plant, and when the process is finetuned and suppliers are stabilized, full-scale production is shifted to its Singapore facility, which Micropolis has owned and operated since early 1986.

Customers agree that the strategy has worked. "Micropolis has been very responsive, it [has] an excellent product and they are a very good vendor," says William Greenlund, AST Research Inc.'s product line manager for the Premium/286, AST's personal computer. AST multisources from Control Data Corp. and Microscience International Corp., as well as Micropolis, for 40MB and 70MB formatted drives. Greenlund says Micropolis lives up to its claims of high-quality and very low mean time between faliure (MTBF); and that AST has had very few problems with failure of units.

To date, Micropolis' strategy has enabled it to grow from $23 million in sales for 1982 to $288.3 million last year. Between 1985 and 1986, Micropolis increased sales a whopping 125%. But it is doubtful that growth rates of that magnitude will ever be seen again. James Stone, a vice president and analyst with Merrill Lynch in New York City, expects Micropolis' sales to grow at between 20% and 30% in 1988, a similar figure to its performance in 1987. Stone agrees with other analysts that this year's revenue will be fairly evenly distributed between the three primary products: 85MB, 170MB and 380MB drives.

The storage demands of high-end personal computers are encroaching on the domain of the workstation and Micropolis sees opportunities there for its old 50MB drives as well as its maturing 85MB and 170MB drives. Likewise, in the supermini and high-end workstation environment, Micropolis intends to exploit the demand for high-capacity, high-performance storage, with its unique 1.5-gigabyte parallel array product.

But it does not stop there. Micropolis is spreading the risk further afield. The company is coming out with a half high 5.25-inch 170MB drive and is working on a 760MB

STUART MABON: Micropolis' chief executive and president: "We cannot afford to take advantage of a shortage or to take advantage of a failure of a competitor"

Michael Grecco

drive that will be out by early 1989. Micropolis is also planning the introduction of a 3.5-inch drive sometime in 1989 and continues to spend some research and development funds on optical disk research, although nothing is planned in that market.

Giving birth to the 380

The opinion from the sidelines is unanimous that diversification is essential if Micropolis is to stay competitive. The 85MB drive is fading fast as the choice in the workstation market and the competition is stiff in the new 380MB market from the likes of Control Data Corp. and Maxtor Inc. Since Maxtor introduced its 380MB product in 1986, about 11 other companies, including Micropolis, have entered the market.

Maxtor had a clear lead in the development of its 380MB drive when it ran into supply problems for thin-film drive heads. A nine-month leadtime to market was virtually wiped out by not having a stable supply line. As a result, analysts speculate that Micropolis has a good chance to capture a sizable chunk of the 380MB market.

Sun Microsystems Inc., one of Micropolis' customers, is qualifying vendors for its new "high-capacity" program, says Greg Michael, product line manager for I/O subsystems at Sun. The new system will be in both a desktop and a desk-side configuration, says Michael, and two 380MB disk drive suppliers will be qualified for each system. Micropolis is in the running. Currently, Sun buys both 85MB and 170MB drives from Micropolis as well as units from Toshiba Corp. and Fujitsu Ltd. Similarly, Altos Computer Systems is rumored to have qualified Micropolis for its 380MB drive.

"The process of moving a new disk drive from the laboratory pilot line environment to volume production is akin to giving birth," says Mark Obenzinger, vice president and analyst with investment firm Wood Gundy Ltd. "It takes about nine months before the results are evident." By Obenzinger's reckoning, Micropolis is near delivery for its 380MB drive now. He estimates that the company will move about 8,000 to 10,000 380MB drives this quarter, ending March.

Such a volatile market demands strong management, and consensus from analysts is that Stuart Mabon, Micropolis' chief executive and president, has the right stuff. "I think Stu is a very close controller of the all important parts of the company," comments William Easterbrook, vice president and analyst with Kidder, Peabody & Co. "I think he runs Micropolis with the velvet glove but there is an iron fist underneath. It is exactly what you need in an industry like that," he adds.

Up, up and array

Much of the minicomputer drive business has been controlled by Japanese makers of 8-inch, 9-inch and 14-inch drives. For the over 1-gigabyte worldwide market, Disk/Trend Inc., a market research firm, estimates that Hitachi and Fujitsu combined accounted for over 60% of all shipments in 1986. But with the U.S. dollar's plunge in relation to the yen and the push by companies like Micropolis, Japan is being competitively compromised. Says Mabon: "We are more of a threat to them than they are to us."

For Micropolis, 1988 will be remembered as the year of diversification. And if all goes according to plan, 1989 will be the year of the big payoff

Micropolis' new 5.25-inch clustered 1.5-gigabyte drive is in development now and is being beta tested by a handful of customers. Commercial shipments will start later this year and then take off in 1989. Analyst Easterbrook believes that the clustered drive will only bring in between $5 million and $10 million this year, but will reach the $10 million per quarter level next year. "The cluster product will be a very, very major product for Micropolis," agrees analyst Stone.

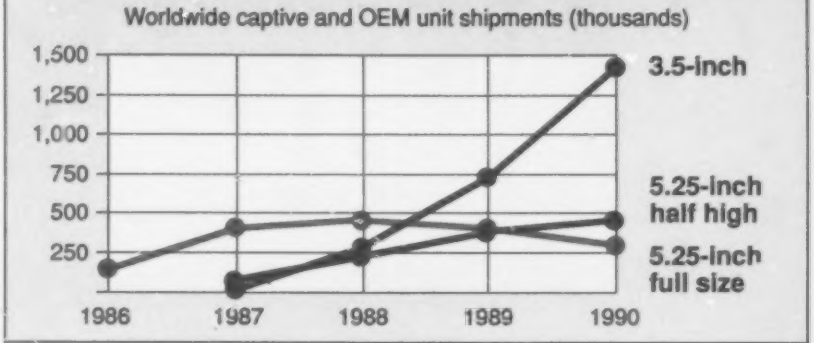
Although Micropolis is on the leading edge for the first time with this product, Mabon insists the risks are minimal. From a marketing perspective, Micropolis will sell the parallel array to existing computer customers like Data General Corp., Hewlett-Packard Co., Sun Microsystems Inc., Unisys Corp. and Wang Laboratories Inc. Also, systems integrators will be targeted as they too sell superminis, high-end workstations, and graphics and imaging systems that demand high-capacity storage. With a dedicated sales staff for the array product, and a high visibility already, Micropolis claims to be well positioned to pressure the Japanese.

On the technical side, much of the innards of the arrayed product are tried and tested. In essence, the unit hooks five 380MB 5.25-inch drives together. What distinguishes it from the daisychaining of drives that has been done by other vendors for years, is that Micropolis has radically improved the reliability of the unit.

By replicating the way a tape drive operates with one drive acting as the parity drive, Micropolis has been able to raise the MTBF of the cluster to 140,000 hours at a sustained data transfer rate of 4MB per second. This is almost five times higher than most 5.25-inch single drives. It uses the small computer system interface (SCSI). "Some customers like the performance, some the packaging, some the price," says Chet Baffa, senior vice president for marketing and sales for Micropolis. At around $12,000 per unit, it is competitive with the larger drives on a megabyte-per-dollar rate.

But just because Micropolis is the first to announce its product does not mean the competition is far behind. U.S. Design, a subsidiary of Maxtor

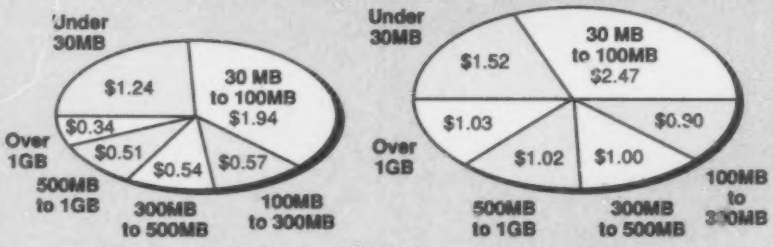
For 5.25-inch disk drive makers like Micropolis, new product development is essential



Source: Disk/Trend Inc.

As demand for disk drives shifts toward higher capacity...

OEM worldwide fixed disk drive revenue ($ billions)

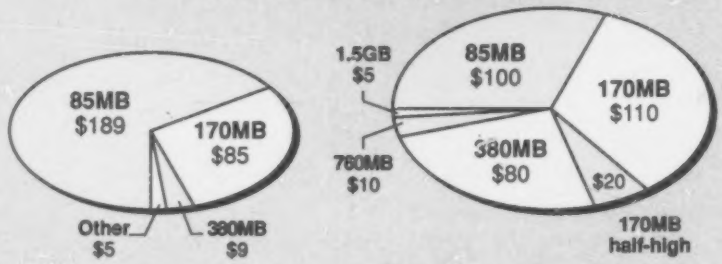


Total 1987 revenue: $5.14 billion

Total 1990 revenue: $7.94 billion

...Micropolis' product mix shifts, too

Estimated product mix ($ millions)



Total 1987 revenue: $288 million

Total 1988 revenue: $325 million

Sources: Disk/Trend Inc. (top), Kidder Peabody (bottom)

Corp., is pushing its 3-gigabyte cluster, as a handful of other vendors are doing. Even IBM is rumored to be making moves in the cluster market. Success in this market will depend on time to market and smoothing out production problems. The clustered drive could prove to be a huge success for Micropolis but Mabon is being cautious with his forecast: "It is still too early to tell," he claims, just how much business Micropolis can expect.

At the other end of the market are the personal computer makers who are also faced with storage-intensive software applications. This is particularly the case with the upcoming gluttenous OS/2 operating system used in the IBM Personal System/2, which demands some 40MB of memory simply to run. Micropolis has no intention of competing with the likes of Seagate Technology and Miniscribe Corp. by developing disk drives for the PC market, claims Mabon, but it does intend to take advantage of the increasing capacity demands. To this end, Micopolis is pushing its 85MB and 170MB drives through new channels and in new parts of the world.

Although a late entrant, Micropolis is starting to place its products on the shelves of electronics distributors and value-added resellers. "It looks like a good opportunity for them," comments Wood Gundy's Obenzinger. Micropolis already has deals with Hall-Mark Electronics, Kierulff Electronics (now a part of Arrow Electronics) and Wyle Laboratories, as well as a host of international distributors.

In total, distribution sales in 1988 are expected to double from around 10% in 1987 to around 20% in 1988, analysts estimate. About 40% of total distribution sales are in the old ST506-formatted 85MB drives but this year, says Baffa, Micropolis will also start pushing the 170MB and 380MB drives through distribution.

Specifically for the distribution upgrade market, Micropolis is introducing a new 170MB SCSI and 170MB ESDI (enhanced small-disk interface) PC Pack designed for PC ATs. It is a follow on from its PC Kit, an 85MB ST506 drive introduced over a year ago. There are rumors circulating that Seagate will be supplying ST506 drives to IBM for its low-end PS/2s, which means Micropolis' PC Kit might take on a new lease on life in the IBM-compatible aftermarket.

The blossoming of Micropolis' personal computer drive was not intentional. "We didn't plan it this way, but we are delighted to see the development take place and we are trying to exploit it as best we can," says Mabon. And the best way to do that is to go to where the decisions are being made.

In the case of the IBM-compatible marketplace, that often means setting up deals with companies in the Pacific Rim. "This is one of the big pushes for the year," says Mabon, referring to Micropolis' push into the Far East personal computer market. Recently, Micropolis set up a marketing office in its Singapore facility to service the reseller market in the Far East. Currently, the majority of foreign sales are to Europe, where Micropolis has marketing offices in England, France and Germany. Foreign sales have declined from 37% in 1984 to 22% in 1986 and are estimated at around 25% for 1987.

But, while opportunities are opening up in the PC and supermini markets, they are closing down with some of Micropolis' older customers. In 1986, Digital Equipment Corp. accounted for over 34% of Micropolis' production. Now, Digital is bringing a lot of its production in house and phasing Micropolis out, especially in the higher capacity arena. Analysts agree that Digital purchased only $40 million, representing about 15% of Micropolis' sales, in 1987. Hewlett-Packard is also cutting down its outside purchases, analysts say, while challenging disk drive makers in their own merchant market. "HP is coming on strong," admits Baffa. Mabon agrees: "HP is going to be a competitor to keep a watch on," he says.

As the capacity and performance of drives from merchant makers increase to 380MB and beyond, captives like Digital and HP are being challenged on their own turf. "What has happened, is the [disk drive] industry has collided with the internal divisions that thought they had a protected market," says Mabon. Micropolis must be able to compete with computer makers like DEC and HP to the point where they have no choice but to buy externally. That means Micropolis must keep its margins down to around 24% and wait it out. "We cannot afford to take advantage of a shortage or to take advantage of a failure of a competitor," says Mabon. "It is really important to us to organize our business around margins that would keep our customers out of the business of making disk drives," he comments. □

DATABASE

Better, but not yet great

The decreases in new orders and shipments for November, although still large, were not quite as severe as the preliminary figures indicated. Revised data from the Department of Commerce place the drop-off in new orders at 14.8% from October to November, instead of 18.5%, and the decrease in shipments at 9.3% rather than 13.2%.

New orders for December regained some of the loss, posting an increase of 4.9%. Computer and office machinery manufacturers had new orders of $55.8 billion for the year 1987, an increase of 3.8% over 1986. Shipments came back 2.1% in December to bring the yearly total to $56.2 billion, virtually the same as the year before. Shipments will have grown almost 11% by the end of this year.

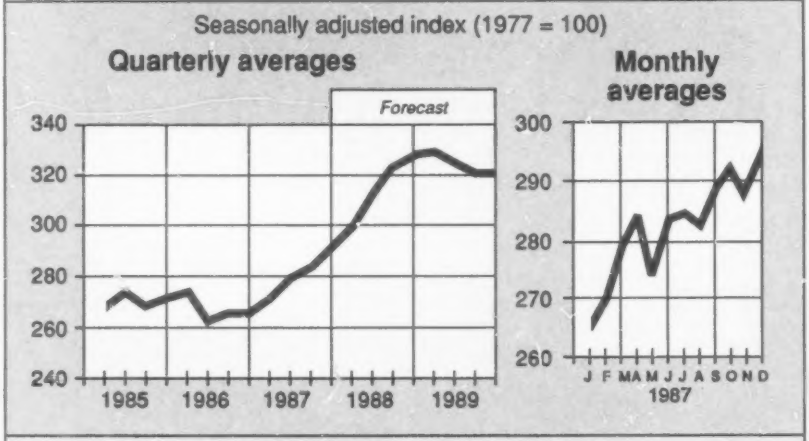
Exports of computers and office machinery surged 11.2% from October to November (note that these figures are not seasonally adjusted), while imports plummeted 17.6%. The $1,883.5 million in exports for the month represented an increase of 31%, compared with the level in November 1986.

Total employment in the computer and office machinery industry averaged 458,700 persons in 1987, 16,500 persons less than in 1986. Employment of production workers dropped 7.8% to average 149,800 persons.

Edited by LINDA STALLMANN

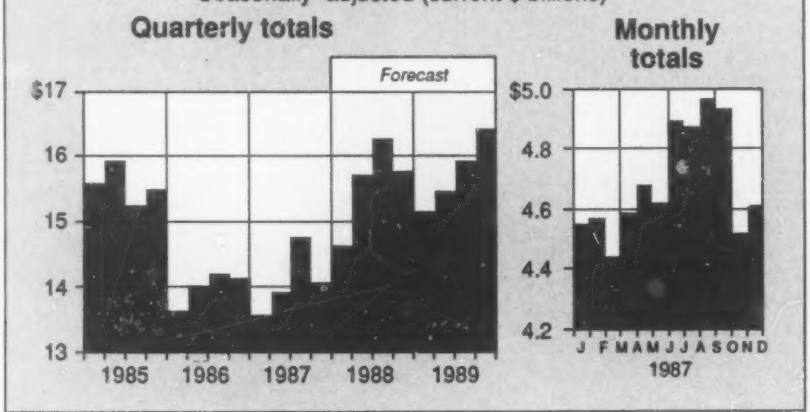
More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, MA 02158 Phone: (617) 964-3030.

Industrial production index for computers



Source: Federal Reserve Board; Forecast: Cahners Economics

Shipments of computers



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, December)	294.6	287.2	+2.58%	267.3	+10.21%	329.50	+11.85%
Shipments (SA, $ millions, December)	$4,607	$4,514	+2.06%	$4,956	-7.04%	$5,260.12	+14.18%
New orders (SA, $ millions, December)	$4,530	$4,309	+5.13%	$4,883	-7.23%	$5,227	+15.39%
Unfilled orders (SA, $ millions, December)	$19,039	$19,116	-0.4%	$19,229	-0.99%	$20,254.1	+6.38%
Inventory-to-shipment ratio (SA, December)	2.16	2.17	—	1.99	—	2.03	—
All employees (thousands, December)	470.1	464.89	+1.12%	461.5	+1.86%	492.37	+4.74%
Production workers (thousands, December)	153	152.9	+0.07%	152.7	+0.2%	159.93	+4.53%
Exports ($ millions, November)	$1,883.53	$1,693.52	+11.22%	$1,434.1	+31.34%	$1,798.02	-4.54%
Imports ($ millions, November)	$1,783.99	$2,164.14	-17.57%	$1,620.53	+10.09%	$1,775.33	-0.49%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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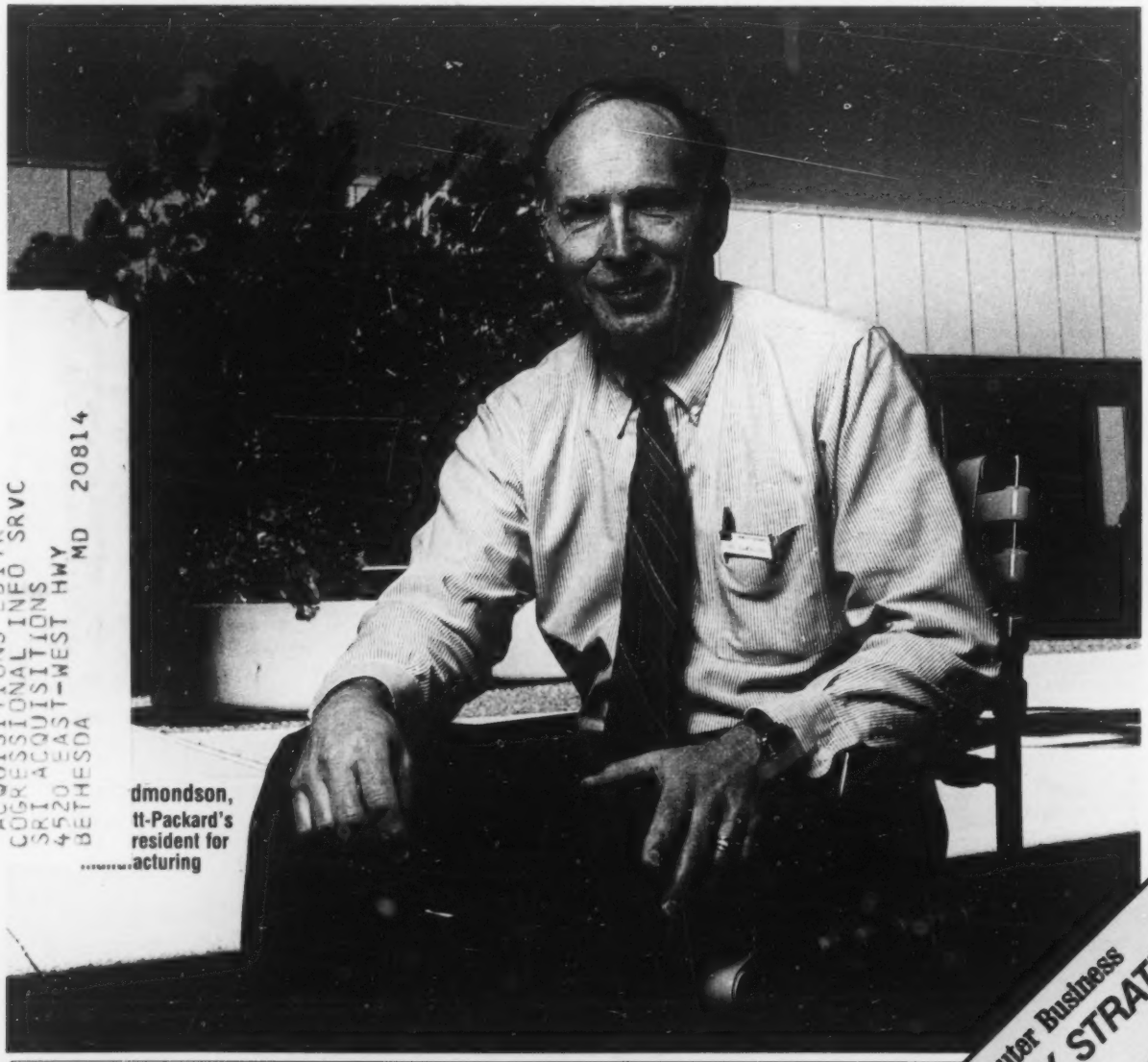

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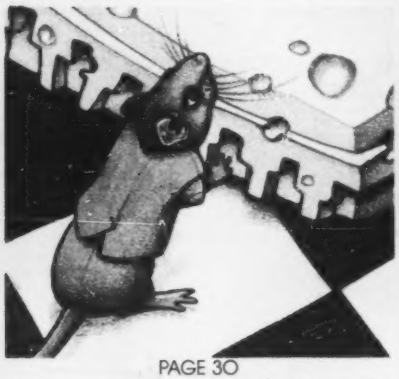

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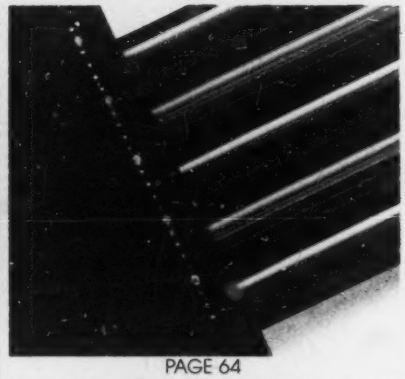

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Cover photo: Cindy Charles

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VBPA ABP

Mark, Mark Twain, mark modems

Reports of their death are highly exaggerated. Will videotex give modems their next lease on life?

Eighteen years ago, after the FCC allowed MCI to compete with AT&T, Datran got approval for an all-digital network. Industry pundits then predicted the demise of the modem business, which was owned by AT&T, and had attracted a small but growing crop of start-ups such as Milgo, Paradyne and Penril. Modems allow the analog phone network to transmit digital signals.

Today, Datran is defunct and modems are mushrooming, but the ever-tightening bonds between computers and communications continue to cast a shadow on the modem's future. Like Mark Twain, modem companies by now are so used to reading about their own premature death that their obituaries must sound like a sticky tune in their ears.

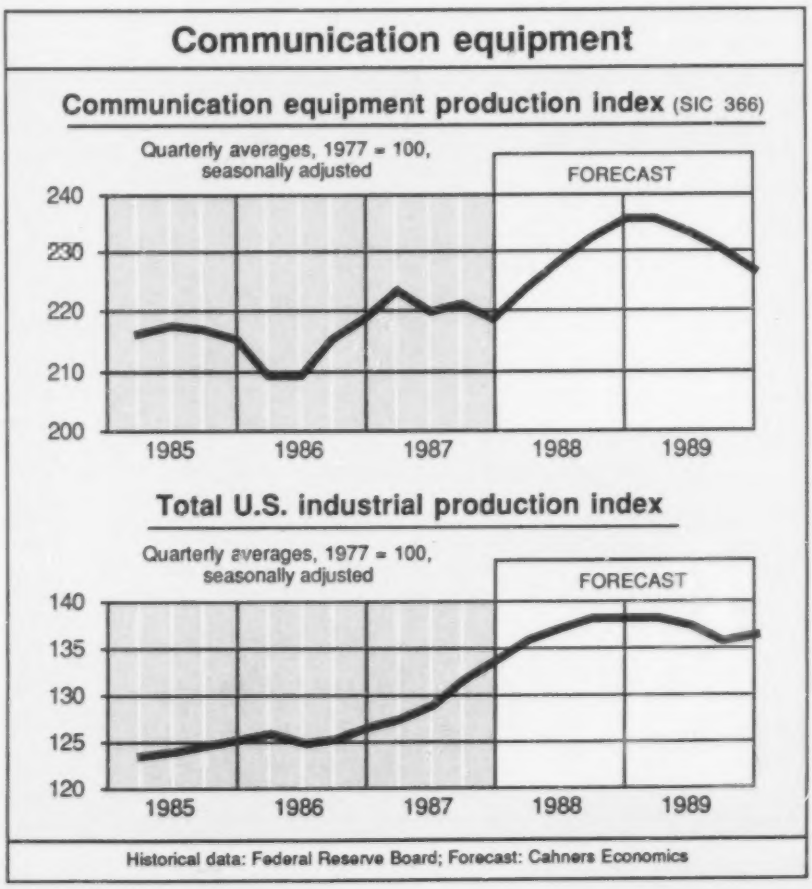
There is a less obvious threat: modems get cheaper all the time. The old modem companies have expanded into datacommunications and network management equipment. The younger manufacturers, however, which make their money from people who connect PCs to the telephone network, are very much affected. "Hayes' unit sales have grown 30% in 1987, but their revenue remained relatively flat at $120 million plus," says Richard L. Villars, senior market analyst at International Data Corp., about the leading manufacturer of modems for PCs.

Hayes Microcomputer Products Inc. will provide 1,200-baud duplex modems for Trintex's videotex service. This 4-year-old joint venture of IBM and Sears, Roebuck & Co. has been testing its Prodigy Interactive Personal Service since November. The venture hopes to serve, over telephone lines and MCI's network, a million PC users nationwide by the early 1990s. Videotex has not caught on in the U.S. "There is no market for interactive services over cable," says John C. Malone, president and CEO of Tele-Communications Inc. (TCI), the largest operator of multiple cable systems in this country, "not until fiber optics makes two-way communications cheaper."

IDC's Villars says that opportunities such as videotex are already factored in his no-growth forecast for the 1,200-baud full-duplex modem worldwide market at $230 million for 1988. He does predict growth of 15% for the 2,400-baud market, noting that Hayes may be called to provide the higher data rate modems. Indeed, Rockwell Int'l Semiconductor Products Div., which Villars ranks as the largest supplier of modem chips and as Hayes' major vendor, sells more of the higher speed chips. "We surpassed a million of the 2,400-baud full-duplex chips [after two years] last October," says Rockwell's modem product manager Dudley Westlake.

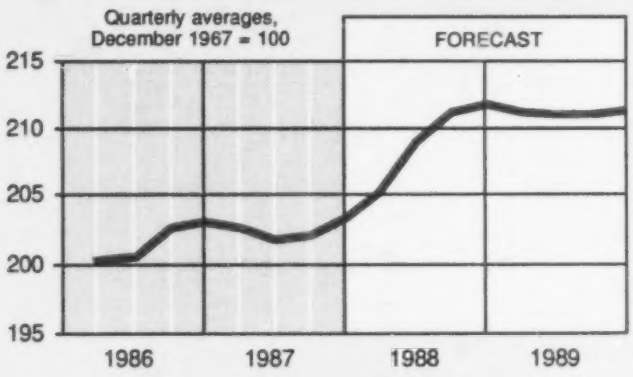
Since Hayes' modems are made in the U.S., they contribute to the index of industrial production for communications equipment. However, this index is heavily weighted with military communications equipment, which is the reason Cahners senior economist Elizabeth Baatz forecasts only a 4% growth for this year. Even without videotex, modems should do much better.

ALBERTO SOCOLOVSKY

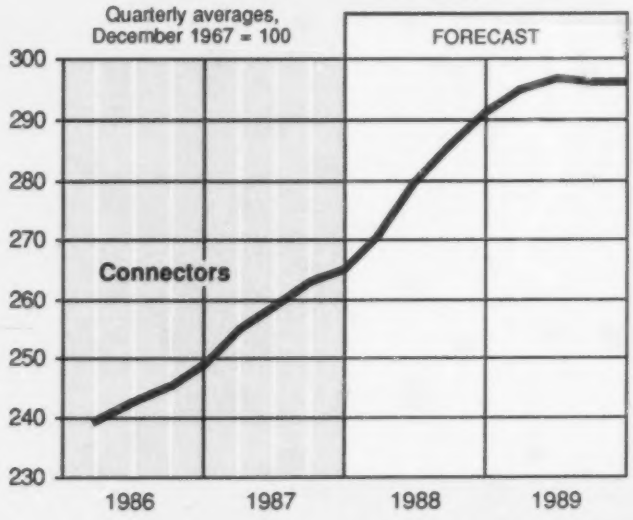


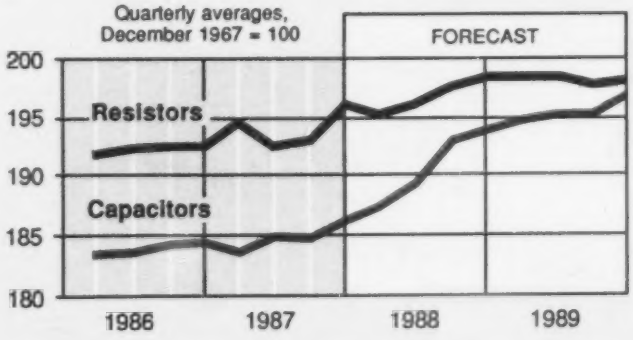
Producer price indexes

Electronic components and accessories (SIC 1178)



Passive components





Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic Components
Producer prices for electronic components rose a slight 0.2% in the fourth quarter of 1987 over the comparable quarter in 1986. For 1987, the annual inflation rate for components rose just 0.5%. This was the lowest annual price increase since 1976. In the first half of 1988, prices are beginning to rise more rapidly. By the end of this year, component prices are expected to increase 3.3%, according to Cahners Economics. At the moment, supply-demand pressures for memories and sub-micron components are forcing prices higher. But end-market demand is likely to trail off by the end of 1988 and early 1989, holding further price increases steady.

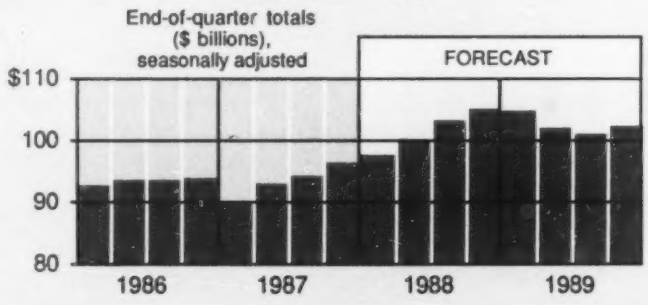
Capacitors
After five years of declines, producer prices of capacitors rose 0.5% in 1987 and are expected to jump 3.2% this year. Much of 1987's price increase came in the final quarter of the year, when prices rose 1% above a year ago. The impetus for price increases comes from rising demand. According to the Electronics Industry Association, U.S. factory sales of capacitors grew over 15% last year. This was the best sales growth since 1984, when capacitors soared 25%.

Resistors
Prices of resistors rose 0.9% in 1987 and are headed for a 1.4% increase this year. These modest price increases are being maintained despite the growing demand from computer and other end markets. Evidence from *Electronics Purchasing's* survey of buyers also shows that supplies of resistors are in relative balance with demand. The length of time from placement of an order to delivery (leadtime), increased 6% in 1987 and is expected to rise another 10% in 1988. But these increases during the tail end of an economic recovery are relatively modest compared with 1984, when resistor leadtimes surged 21%.

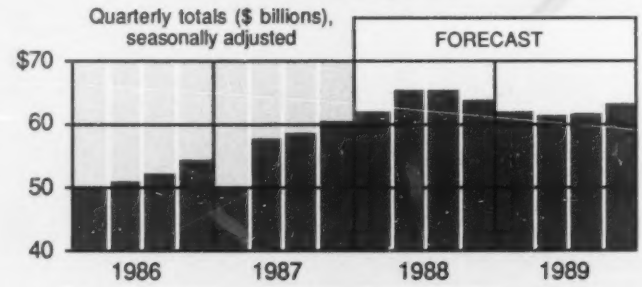
Connectors
Unlike most other passive components, prices of connectors jumped over 6% in the fourth quarter of 1987, compared with the year ago quarter. For the year, connector prices rose at a 6.3% annual rate, almost twice as fast as 1986. Connector prices are expected to continue to accelerate this year, rising another 8.3%. Next year, however, connector inflation will head back down to a more modest 5.3% rate.

Electrical machinery (SIC 36)

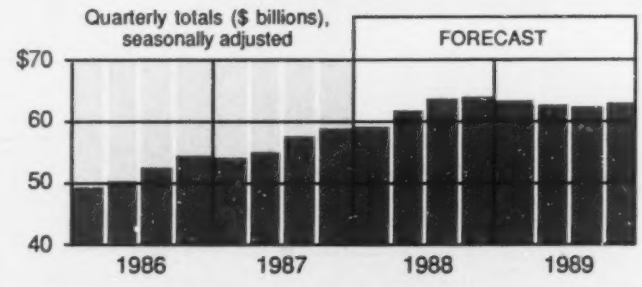
Unfilled orders



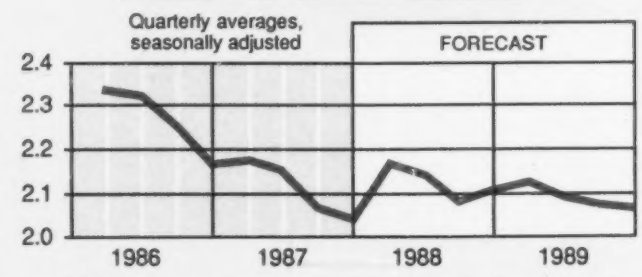
New orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

New orders for electrical machinery grew 3% in the fourth quarter of 1987 from the prior quarter. This brought total annual orders to $226.2 billion, an increase of $19 billion, or 9.5% over 1986. Of this $19 billion, new orders for electronic components accounted for 46%. Miscellaneous electrical machinery like batteries, electromedical equipment and engines accounted for 27% of the new orders and electrical transmission and distribution equipment accounted for 11%. New orders are expected to grow over 13% this year before falling in 1989.

Unfilled orders

Unfilled orders for electrical machinery topped $96 billion in the final quarter of 1987, $2 billion higher than the third quarter. Most of 1987's increase in unfilled orders was due to an increase in component backlogs. Unfilled orders will continue to rise in 1988 before declining slightly in 1989. But with plenty of factory capacity still available, unfilled orders are not expected to rise above $105 billion. Factory capacity stood at 76.6% in January, still far below the 81.9% peak capacity utilization rate seen in 1984.

Shipments

Rising 1.9% in the fourth quarter of 1987, shipments of electrical machinery totaled $223.9 billion for all of 1987, a 9.4% increase. As with new orders, electronics components and miscellaneous electrical equipment shipments grew fastest, in the 13% to 14% range. Communication equipment shipments rose 6% and TV/radio equipment inched up 2%. With shipments increasing slightly slower than new orders, the book-to-bill ratio for electrical machinery managed to stay above one for the last nine months in 1987. This is the steadiest positive book-to-bill ratio since 1984. A positive book-to-bill ratio is considered a good indicator for the future. Shipments are expected to increase 9.9% this year and 1.3% next year.

Inventory-to-shipment ratio

The inventory-to-shipment (I/S) ratio for electrical machinery dropped just below two in December 1987. Not for over 16 years has this ratio been so low. A 9% increase in shipments in 1987 was met by only a 1% rise in inventories. The uncertain nature of the current economic recovery coupled with computerized inventory management has been causing a long-term downward trend in industrial I/S ratios, while retail and wholesale I/S ratios have taken an upward turn at the end of 1987. For industrial manufacturers, low inventories mean production schedules should continue unhampered this

OPTICAL DRIVES

WORM drives wriggle toward acceptance

Despite their lack of data-interchange standards, sales of write-once optical memory drives should double by 1990

After a slow first few years, the market for optical disk drives is starting to show signs of life, especially the segment for write-once read many times (WORM) devices. Worldwide revenue for WORM drives climbed to $265 million last year and will top the $1 billion mark in 1990, estimates market research firm Freeman Associates Inc. of Santa Barbara, Calif.

Optical drives are finding a niche in computer applications where the sheer bulk of stored data overwhelms conventional magnetic devices. At the low end of the WORM spectrum, 5.25-inch disks can hold upward of 200 megabytes of data. At the high end, 12-inch and 14-inch disks start counting at 1 gigabyte and go up from there. And, since the plastic discs are removable (unlike the platters in conventional Winchester drives), dozens can be stored in optical jukeboxes for quick access at any time.

The main drawback today is that methods are just being perfected to make optical discs erasable. Nevertheless, the more limited write-once format is "perfect for archival applications, especially those that need fast access to data," says Freeman Associates vice president Robert Abraham. In some cases, such as storing legal and financial records, the fact that discs can't be altered is actually an advantage, he notes.

The low end of the optical drive market is dominated by Japanese-made units. Most notable is a 5.25-inch drive made by Matsushita Electric Industrial Co. that computer giant IBM sells for use with its Personal System/2 computers. And disk drive maker Maxtor Corp. of San Jose sells a 5.25-inch drive from Ricoh Company Ltd. — although later this year, it is bringing out an erasable drive it makes itself. U.S. manufacturers include three 4-year-old companies: Laserdrive Ltd. in Santa Clara, Calif; Information Storage Inc. (backed in part by Honeywell Inc. and Japan's Kawasaki Steel) in Colorado Springs; and Optotech Inc., also in Colorado Springs. Another Colorado Springs company, Laser Magnetic Storage International (LMSI — a joint venture between N.V. Philips GL and Control Data Corp.) also recently added a 5.25-inch drive to its higher end product line.

Performance and capacity ceilings for small optical drives are rising, making them more suitable for bigger computers

For the 5.25-inch drives, which have retail prices starting at less than $2,000, "many applications are for storing images, such as CAD/CAM drawings or medical X-rays," says Gordon Knight, director of Maxtor's optical programs. Half of the more than 6,000 drives Maxtor shipped in 1987 went into PC-based systems, he reports. But performance and capacity ceilings for small drives are rising, making them more suitable for bigger computers. For example, Information Storage just introduced a 5.25-inch drive with a 1.28GB capacity that company president Steve Popovich says will be aimed largely at minicomputer based systems.

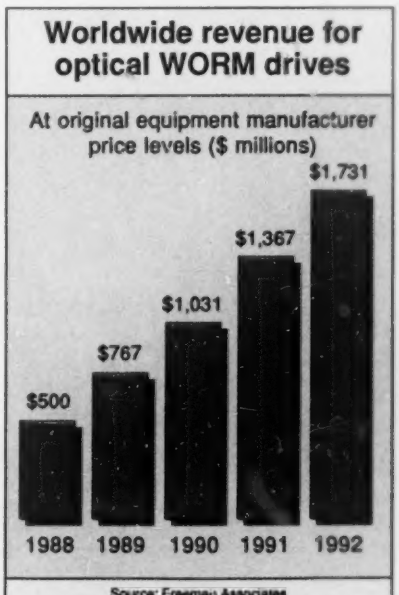
The larger 12-inch and 14-inch drives are aimed exclusively at high-powered systems for managing massive archives of documents and images. For example, Wang Laboratories, the Lowell, Mass., minicomputer maker, introduced a large-scale electronic image filing system last October. It includes digital document scanners and an optical WORM drive jukebox that can store 3.5 million pages of words and images. "As optical disc technology moves forward, it is the obvious direction to take in imaging systems," says Larry Mononen, senior product manager for the new line of equipment. Targeting the federal government and the banking, finance and insurance industries, Wang projects sales of $100 million in the system's first year. For four years, FileNet Corp. in Costa Mesa, Calif., has been selling similar systems, which produced revenue of $52 million for the company in 1987.

The next major use for high-end drives promises to be storage and management of computer data, making microfiche records obsolete in most instances, predicts Phil Shires, vice president for marketing and sales for LMSI, which makes drives for both Wang and FileNet. This helps explain why two photographic heavyweights, Eastman Kodak Co. of Rochester, N.Y., and Bell & Howell Co. of Chicago, recently introduced their own high-end WORM drives.

Optical drives must still overcome several obstacles before success is assured, cautions Robert Katzive, vice president of Disk/Trend Inc., a Los Altos, Calif., market researcher. WORM drives still lack standards, making it impossible to interchange units from different makers. They require complex software and electronics support to become part of larger systems. And they are expensive compared to older alternatives such as microfiche and possible new ones such as digital audio tape. "Optical drives haven't yet lived up to their promise," says Katzive.

SARAH GLAZER

Worldwide revenue for optical WORM drives



COMPONENTS

The connector consensus: Growth, but more shakeout

Connector makers see a double-digit uptick this year. The big question is whether a downturn hits next year — or late in '88

By Bruce C.P. Rayner

Last year saw some major tremors shake up the overcrowded connector industry as companies both big and small bought and sold divisions and restructured operations. Pundits agree the shakeout will continue as aftershocks reverberate through the market in 1988 and beyond. While the market looks healthy right now, many industry watchers expect it to turn sour by year's end.

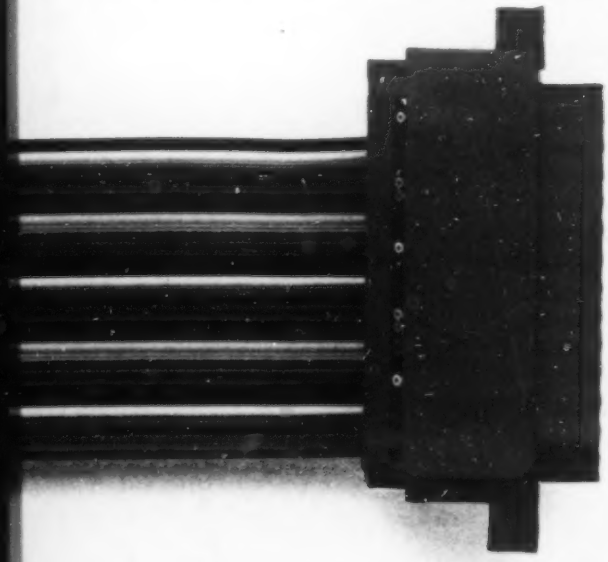
The consolidation trend is all part of the process by which a saturated middle-aged industry preps itself for the new globalization game of the 1990s. Entering niche markets in order to broaden product lines, cutting cost by streamlining operations and offering just-in-time capabilities to quality-conscious customers are all necessary changes taking place in the connector industry.

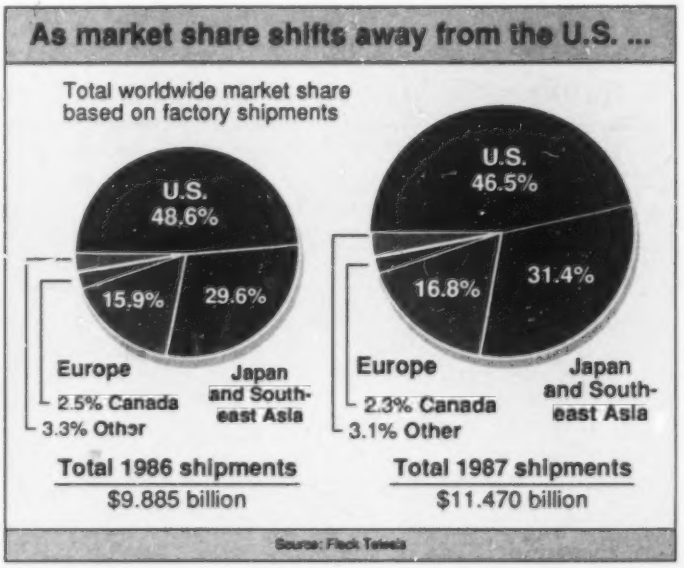
"What we saw in 1987 is a harbinger of things to come," insists James Marley, president of top-ranked AMP Inc., referring to the acquisition binge. "I have a sense that there will be a shakeout in the years ahead that will afford us opportunity for growth." Most of AMP's chief competitors agree that the consolidation means the strong will get stronger and the weak will disappear.

The long-term view is that there are still too many players vying for a piece of the connector pie. Analysts and competitors agree that the more than 600 companies currently in the business could easily be cut in half over the next few years with no detrimental effects to industry capacity. Estimates of 100 companies by the mid-1990s are not uncommon.

Given expectations of a modest 5% to 6% average annual growth rate for the industry for the next five years, coupled with a probable recession either later this year or next year, an acceleration of this paring-down process is likely. All told, last year saw 22 acquisitions and mergers; 11 joint ventures or licensing agreements; and restructurings at eight major corporations, reports Kenneth Fleck, president of the connector market research firm, Fleck Telesis Inc., of Huntington Beach, Calif.

Because of the overcapacity and overpopulation in the market, prices will continue to drop, says Fleck, an average of 2.5% a year over the next four years. Price erosion between 1980 and 1987 averaged 2.9%, Fleck estimates. But in the short-term, price





Top U.S. connector and interconnect suppliers

Source: Merrill Lynch Capital Markets Group

increases are not unheard of. For instance, Don Eisenberg, vice president for sales and marketing at Burndy Corp., says his company posted across-the-board price increases in January and he expects them to stick through 1988.

Whether prices can be sustained depends on the imminence of a recession. The consensus from Wall Street is not positive for the connector market, even though the current picture of the industry looks robust. Says Stephen Balog, a vice president for investment brokerage Shearson Lehman Hutton: "The incoming order picture [from connector makers] and what you are hearing back from the companies is very positive, but no one seems to be very excited . . ."

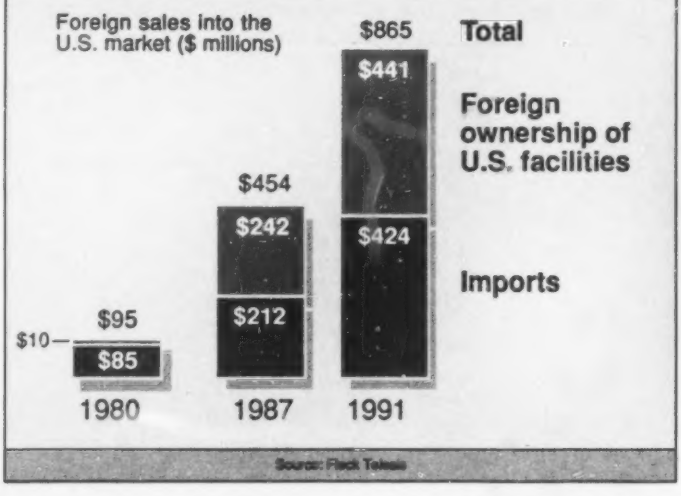
Recession? What recession?

"We are still looking favorably on the year," says Molex Inc.'s chairman, John Krehbiel Sr., "even though we are hearing a lot of noise from the media about a recession." He claims there is nothing on the horizon to indicate a recession anytime soon as both backlogs and customers' reactions are positive. AMP's vice chairman Harold McInnes concurs: "As we look to 1988, we see essentially a continuation of growth in the domestic marketplace of between 12% and 15%."

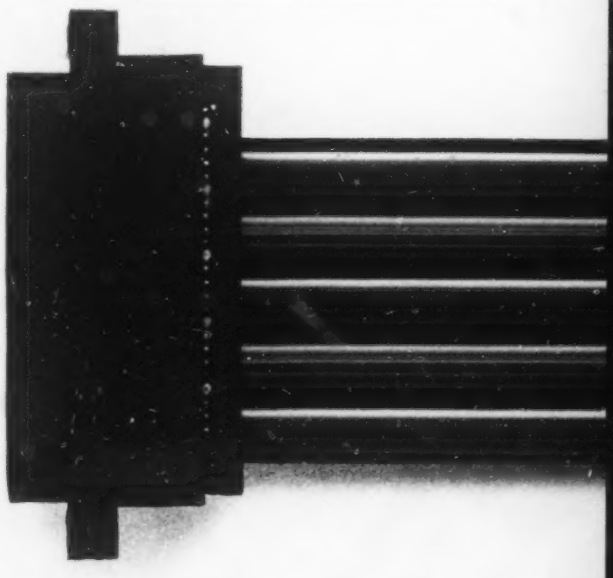
Dominic Pileggi, vice president for marketing in the electronics division of 10th-ranked Thomas & Betts Corp., sees the market as healthy and expects slow but steady growth on the order of 8% to 10% for the year. Eisenberg of Burndy agrees with that range, while E.I. du Pont de Nemours & Co.'s director of the interconnect and packaging group, Michael Emery, expects to grow his connector business between 10% and 15% for the year.

The book-to-bill ratio for most products in the connector industry is

... foreign competition is creeping in



Source: Flack Telesis



Martin Cooke

above parity, customers' and distributors' shelves are not overstocked, backlogs are stretching out and shipments are up, comments Charles Sloane, president of Sloane-Stewart Inc., a San Mateo, Calif., market researcher. But despite the bright picture, Sloane is forecasting the total worldwide merchant connector market to contract by 5.4% to $7.38 billion in 1988, from $7.8 billion in 1987, with most of that contraction caused by the market starting to head south in the third quarter of 1988.

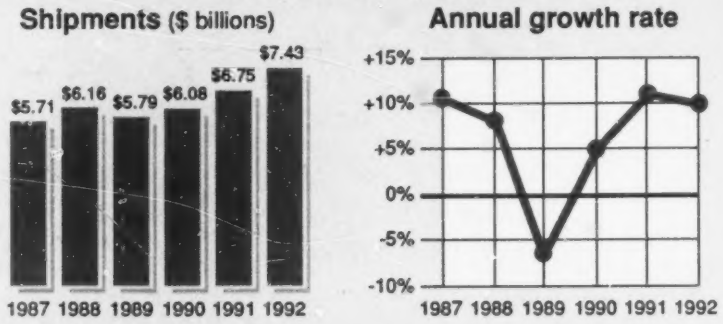
Fleck, on the other hand, sees the connector industry holding its own into 1989 even if the economy turns sour in 1988. Part of the reason is the nine-month lag in the commercial market and the 18-month lag in the military market between a general economic cutback and the time it hits the connector industry, says Fleck. Balog adds some wry optimism of his own: "The most positive thing you can say is that if we are going into a slowdown, at least we won't have to correct for the huge inventory overhangs like we did in 1984."

Adding to the uncertainty for connector vendors were numerous franchise changes and reshufflings within the industrial distribution community. Distribution accounts for around 26% of all connector factory shipments, says Fleck, and is likely to grow to 30% over the next five years. Even AMP, a slow starter out of the blocks, has grown its distribution sales from $30 million in 1981 to about $100 million last year, and sees potential for future growth through distribution. AMP estimates that distribution has a total available connector market of around $1.6 billion.

Leon Machiz, vice chairman of No. 1 distributor Avnet Inc., the parent of both Hamilton/Avnet and Time Electronics, believes both commercial and military connector business is healthy at this point. "The market looks very strong and every indication is that it will continue," he says.

Expect a downturn in shipments next year

Forecast of U.S. connector factory shipments

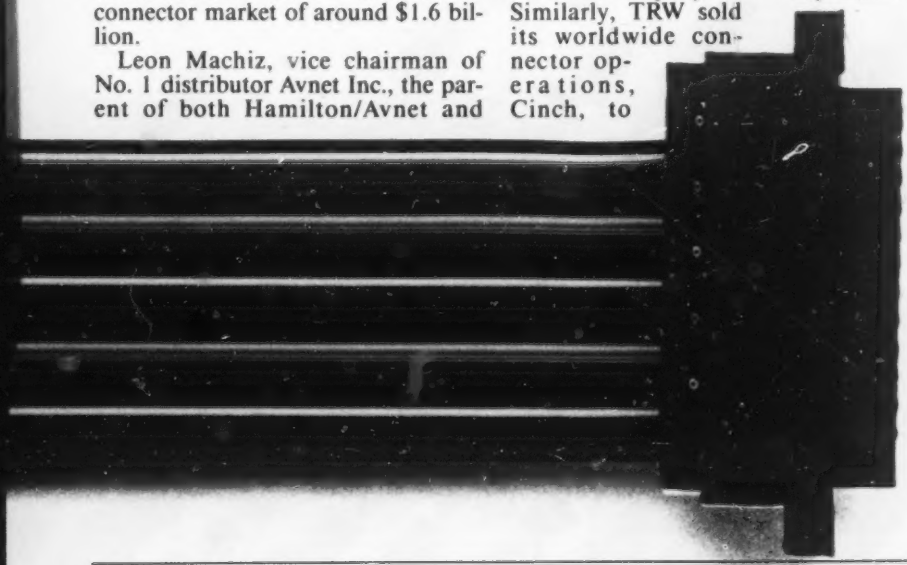


Shipments include connectors, cable assemblies, backplanes, contacts, telephone jack fields, terminal junctions/modules, packaging panels, flexible circuit jumpers and custom-use tools

Source: Fleck Telesis, ELECTRONIC BUSINESS

Divestitures

Nevertheless, connector industry consolidation rolls on. Two of the biggest sales in 1987 involved total divestitures of connector operations by defense industry leviathans Allied-Signal Inc. and TRW Inc. In May, Allied-Signal sold its Amphenol Products Group, a total of 22 facilities worldwide, to LPL Investment Group Inc., a Wallingford, Connecticut-based public investment company, for $430 million. LPL has since sold segments of Amphenol in order to make the company more competitive. Similarly, TRW sold its worldwide connector operations, Cinch, to Precision Mechanique Labinal, a French company, for about $130 million.

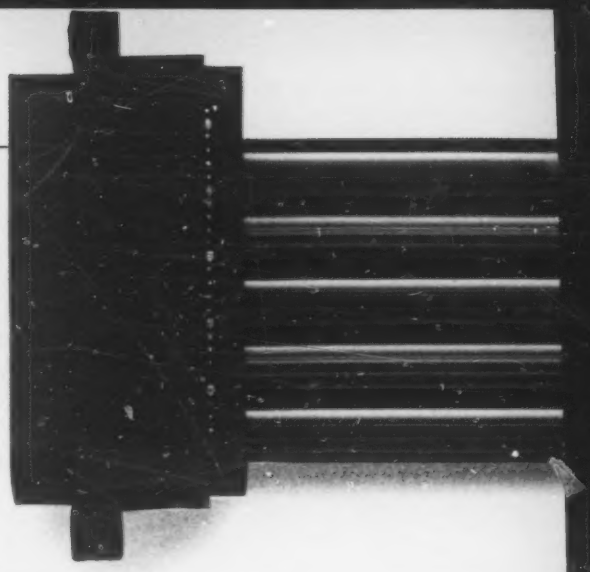


For the industry, the bottom line of such sales is positive, says Jerry Labowitz, a vice president with Merrill Lynch Capital Markets in New York City. Buyers like LPL are streamlining, consolidating, and taking old facilities off line. That means less capacity, higher efficiency and lower costs. "Longer term, this should bode well for the industry, because these buyers are profit-oriented," says Labowitz.

While TRW and Allied-Signal exited the business in 1987, other conglomerates renewed their commitment to the connector industry. 3M Co., often criticized for having too narrow a product offering, entered the fiber optics market in 1987 in a big way with the acquisition of Dorran Photonics Inc. in January and EOTec Corp. in June. Similarly, last year, Augat Inc. integrated Elfab, a backplane supplier, into its operations and purchased Compagnie Teletechnique Moderne SA, a French supplier of modular connectors, to round out its European presence.

As for what's hot in 1988, the big buy is expected to be military connector maker Matrix Science Inc. The Torrance, Calif., company is reported to be actively seeking a buyer. At press time, AMP has close to a 13% interest in the company, but is facing competition from market rival Molex Corp., the fourth-ranked player, with a 6% interest. Most industry watchers expect AMP to win out.

Another factor in the competitive equation is the threat from offshore.



Foreign competition, although dampened by the U.S. dollar devaluation, is intensifying. Japanese connector makers are intent on increasing their market share in the United States by selling through distribution and by focusing on niche markets in custom connectors. Fleck forecasts that foreign sales into the United States will increase from 9.7% of current market share to 14.3% by 1991. Joel Urban, marketing manager at Fujitsu Components of America Inc., in Santa Clara, Calif., says Fujitsu is one Japanese connector maker that has a formal policy for increasing its U.S. presence.

Passing the buck

Surface mount applications have been slow to materialize and fiber optics is still in the realm of long-distance telecommunications, but both are destined to catch on in a big way. For connector makers, surface mount capabilities mean an investment on the order of $10 million, part of the reason for the slow pickup and a factor that is not looked upon kindly by the smaller connector shops. Also, as computer makers pass more responsibility for surface mount boards upstream, they will expect suppliers to offer more than just individual connectors. They will want the entire board assembly, connectors and all. "As that occurs sometime in the next 10 years, it means that connector houses will have to be more involved in the subassembly and the whole packaging of the board with connectors already mounted," says Fleck.

Du Pont's Emery believes that day is already here. "Our customers don't want to buy just connectors," he says. "They want to buy more forward integrated products and they want a supplier that can provide the engineering and then get it all made and put together with the right timing, the right quality and the right cost," Emery claims. "They," in Du Pont's case, are: Apple Computer Inc.; Digital Equipment Corp.; Hewlett-Packard Co.; and IBM, to name a few.

On the fiber optics front, market acceptance in short-link local area networks and inside computers is still around the corner. The market for fiber-optic connectors grew to about $60 million last year, up from $25 million in 1984, largely as a result of long-distance telecommunications business. But now that this segment has reached saturation, vendors like AMP, 3M and Du Pont are waiting for the LAN market to catch on. Fleck predicts 20% annual growth in this market segment over the next four years.

However, very few fiber-optic connector makers are believed to be profitable, analysts agree. Most of the losses are put down to R&D expenses. No surprise, then, that the parent of No. 2-ranked Amphenol, LPL, has been actively seeking a buyer for its fiber optics operation since the middle of last year. □

JIT helps connector users trim those supplier lists

JIT — having a component arrive on the factory floor exactly when it is needed — first gained preeminence in Japan last decade and has now permeated the U.S. and European electronics industries. Most industry watchers agree its effect on the connector industry will be profound.

Customers and vendors alike are maintaining closer control of work-in-process inventory, and programs like statistical process control (SPC) are being implemented on a corporate-wide basis. With dock-to-stock programs gaining popularity among the big computer customers, total quality of components has taken center stage. "The connector market is very different from 1984 because today you have JIT," says Jerry Labowitz, a vice president with Merrill Lynch Capital Markets in New York and a long-time follower of the industry.

"JIT and quality are prerequisites: you have to have them just to play the game," says Michael Emery, director of E.I. du Pont de Nemours & Co.'s interconnect and packaging group. And with the advent of a standard electronic data interchange in the next decade, says Ken Luczaj, vice president for sales and marketing at Litton Industries Inc. Winchester Electronics Division, just-in-time sourcing will take on a whole new meaning for the entire electronics industry, connectors included.

The bottom line in this revolution is that the number of connector vendors that big customers will deal with is declining. It is increasingly common for partnerships to be formed between the customer and a few key suppliers offering a broad range of products.

"Finding a supplier that can provide the right product on time means that many of our customers are having to reduce their supplier lists," claims James Marley, president of market leader AMP Inc.

Unisys Corp. is purging the ranks of its connector suppliers and expects to drop 10 of its 35 vendors in the next few years, says Robert Belzman, manager of procurement and contracts in the component engineering and procurement organization of Unisys, in San Diego. Unisys wants to work with suppliers that maintain close control over their manufacturing processes: that includes SPC programs and parts-per-million calculations of failure rates. Currently, says Belzman, Unisys is looking for a few suppliers to certify for a dock-to-stock program.

Unisys is not alone in its policy. Hewlett-Packard Co. has its own reduced vendor program. Over the past few years, HP has cut its corporate-wide connector vendor agreements from 40 to 25, says Ivan Garrison, commodity manager for interconnect systems at corporate headquarters in Palo Alto, Calif. □

SURFACE MOUNT TECHNOLOGY

These are glory days for SMT production gear firms

They're finally seeing backlogs swell as America embraces SMT. The users' main problem is what to buy, and from whom

By Michael R. Leibowitz

About the time that technicians installed the last piece of equipment on Manufacturing Services Inc.'s first surface mount technology (SMT) production line, Benny Lee, owner of the small, 67-employee contract manufacturing house, went into his office, picked up his telephone and called his vendors with an order for a second line. "I need to support my customers," says Lee, adding that already, his first SMT customer wants 100% of his capacity. With other customers clamoring for SMT production capability, Lee says that he needs more capacity immediately.

These are the glory days for makers of SMT production equipment, who are seeing their order logs swell as the United States finally turns on to SMT. For five years, SMT has been the manufacturing technology of major Japanese and European electronic equipment makers. Within the past two years, however, large, medium and small U.S. producers of electronic equipment have begun to embrace SMT as the standard technology for producing world-class electronic products.

With estimates saying that as much as 75% of Japanese electronic equipment production is now using SMT, and with the popularity of a new breed of high pincount ASIC chips requiring SMT, U.S. makers are finding they have little choice but to bear the high equipment costs, and climb onto the SMT learning curve. Equipment makers are turning the prototype lines they built to learn SMT into full-scale production facilities, while SMT veterans are bringing up additional lines to convert more of their production to SMT. Meanwhile, the novices are enlisting contract manufacturers to help them into the SMT world.

Pamela J. Gordon of Technology Forecasters Inc., a Berkeley, Calif., market researcher, says that last year, the value of printed circuit board (PCB) assemblies utilizing SMT grew a whopping 44%. This compares dramatically with through-hole growth, she says, which barely eked out a 6% growth. It puts the SMT portion of all PCB assemblies, by value, at 12% in 1987, a rise from 9% the previous year.

Royal flush

Accordingly, SMT production equipment makers find themselves flush with orders. They report particularly strong demand in the United States and the Pacific Rim, with Europe also contributing good growth. Universal Instruments Corp., for example, reports an 80% increase in SMT business during 1987. Fuji America Corp.'s general manager, Iwao Yamaguchi, calls 1987 sales of his company's SMT production gear "quite brisk."

By most estimates, 1988 is shaping up to be another great year. Universal's James Roth, vice president for marketing and sales, expects his SMT business to double in 1988. Fuji America's Yamaguchi, based in Elk Grove Village, Ill., sees 1988 as a "straight extension of 1987."

Charles-Henri Mangin of Ceeris International, an Old Lyme, Conn., market consultant, says that the first half of 1988 will be "very good," with a possible slowdown, reflecting last October's stock market crash, occurring in the second half. And Technology Forecasters predicts that U.S. sales of SMT production equipment

UNIVERSAL INSTRUMENTS' ROTH: Expecting his SMT business to double in 1988

will grow 34% in 1988 to $377 million, from $282 million in 1987. The SMT portion of all circuit board assemblies will top 15% in 1988.

The infant production equipment industry is in a phase in which each year brings a wealth of new and innovative items. The 1987-88 edition of the *Surface Mounting Directory*, published by Info-Mation Inc. of Warrington, Pa., lists 1,155 items of SMT production and test equipment from 239 manufacturers. This is up 22% from 947 equipment items in the 1986 edition.

Vendors typically fall into one of three categories: Japanese and European broad-range suppliers of high-volume production equipment, such as Fuji Machine Manufacturing Company Ltd., Panasonic Industrial Co., N.V. Philips GL, and TDK Corp.; American broad-range producers of high-flexibility production equipment, such as the Dynapert division of Emhart Corp. in Beverly, Mass., and Universal Instruments Corp. in Binghamton, N.Y.; and specialized producers of medium- and low-volume equipment of a particular type, such as Excellon Automation, a division of Excellon Industries, in Torrance, Calif., Quad Systems Corp. in Horsham, Pa., and Vitronics Corp. in Newmarket, N.H.

While customers are clearly benefiting from the explosion in new products dished up by these vendors, it has imposed big challenges on them. Vendor and equipment selection is "a difficult, long, drawn-out, expensive process," says Info-Mation's president, Donald Brown, who adds that the process can take as long as a year.

Customers report that nowhere other than in the process of selecting SMT gear is it as important to figure out precise requirements, such as volumes, board mix, types of components to be handled and degree of automation required.

Kicking the tires

For evaluating speed, an increasing number of SMT equipment customers are ignoring vendor claims and are instead, asking vendors to run an actual board through their pick-and-place machines. Placement speeds vary considerably depending on the particular board being run, and actual placement speed — a critical decision criterion — rarely comes close to vendor specifications. James Elliott, director of advanced manufacturing at computer peripherals maker Western Digital Corp. in Irvine, Calif., recommends asking vendors to set up their machine for an actual board and says most vendors will comply.

Contract manufacturers will be buying more SMT production gear, too

Source: Technology Forecasters

Reliability is more difficult to measure, and SMT equipment users say that the only way to evaluate this is to talk to other users. One user visited local references supplied by his equipment manufacturers while Robert Rowland, manager of disk drive maker Iomega Corp.'s printed circuit assembly engineering group in Ogden, Utah, talked to current users and relied on his previous experience with Universal equipment as a guide. Western Digital's Elliott traveled to Japan to visit the factory and talked to Sanyo Electric Company Ltd. users there. "They were building the same machine for 10 years," Elliott says. "I talked to some and found that they were very happy and had purchased more through the years."

One of the biggest areas of controversy facing customers today — and one receiving much attention by vendors — is the question of buying a line from multiple vendors versus buying the ensemble from a single, broad-range vendor. Besides offering compatibility for connecting machines together into an automated, integrated system, buying from a single vendor has the advantage of one-stop service with no finger-pointing between vendors.

On the other hand, with the explosion in new, innovative products, some customers prefer to pick and choose. Cincinnati Microwave Inc. built its integrated, automated line with equipment from several manufacturers. "We felt like we would get as good a capability for less money," says Jon Prokop, engineering manager of the company's advanced manufacturing group. "And, there was some possibility that we would be able to meet our requirements better," he adds. "Everybody I've talked to with a completely turnkey job has always gotten one item they [com-

The accuracy urge

Other big changes in the SMT equipment market include the move to more accurate pick-and-place machines, for handling the new generation of high lead-count ICs with lead spacings of 0.025-inch and less. Many IC pick-and-place machines that are now shipped utilize vision systems, according to Maurice Sage, managing director of BPA Ltd., an SMT researcher and consultant in Cold Spring Harbor, N.Y. Vision systems examine the orientation of the component and the board and instruct the placement head to make corrections where necessary.

Sage says that vendors have more work to do in the area of accuracy. "Placement accuracy is limiting the yield," he says, adding that typical misplacement rates of 100 parts per million are unsuitable for high-volume, high-value customers who must slow down their machines in order to get suitable yields. But market consultant Ceeris International's Charles-Henri Mangin, says accuracy is no longer a problem, and that it was not a simple task for pick-and-place makers to improve their machines from 10,000 parts per million, the misplacement rate of 1983, to 100 parts per million. "But it's going to be a lot more expensive" to go to 10 parts per million, he says.

Leading pick-and-place machine makers, according to Mangin, include: U.S. makers Dynapert, Excellon Industries, Quad Systems Corp. and Universal Instruments Corp.; and Japanese makers Fuji, Panasonic Industrial Co. and TDK Corp. N.V. Philips GL is another pick-and-place leader. □

JAMES MITCHELL OF QUAD SYSTEMS: "About half of the equipment we are asked to quote on is to the SMEMA standard"

plain] about a year later."

The trend toward automation — tying machines together to eliminate manual transfer of boards — is a major factor fueling the single- versus multiple vendor controversy. SMT production equipment makers report that more and more customers are opting for the integrated approach to reduce labor costs and improve quality. According to Universal's Roth, 55% to 60% of the company's SMT business was in systems in 1987, up from 25% in 1986. In 1988, he predicts, it will approach 80%.

And in the move toward automation, broad-range equipment manufacturers have the natural advantage. Their machines bolt together and have provisions for communicating among each other and with a central controller. Since broad-range vendors offer most pieces of the line, they can sell customers integrated, turnkey systems using their own equipment, filling in the holes with third-party gear where necessary.

Plight of the specialists

The broad-range vendor's ability to ship turnkey systems contrasts with the plight of specialty vendors who often manufacture and sell only one portion of the line and do not have the other pieces to integrate. In fact, until recently, customers could not do this integration themselves: the equipment of one vendor would not mate with the equipment of another.

Within the past year and a half, however, specialty vendors of single machine types have gotten some help from the standardizing activities of the Surface Mount Equipment Manufacturers Association (SMEMA), which has developed and published standards for mechanical and electrical interfaces of individual machines. Many specialty vendors are already producing equipment to the SMEMA standard and there are indications that customers are embracing the standard. James Mitchell, president of pick-and-place machine maker Quad Systems and past president of the SMEMA, says that currently "about half of the equipment we are asked to quote on is to the SMEMA standard."

But, while specialty vendors standardize, broad-range suppliers are filling in the holes in their product lines to provide more of an integrated "solution" to customers. TDK uses third-party equipment to fill in the gaps in its line, according to TDK Corp. of America's Asahi Yoshitomi, based in Skokie, Ill. He expects a full 60% of his business to be integrated systems in 1988, whereas in 1987, he was mostly selling single machines. Dynapert, to lure more systems business, recently introduced an infrared (IR) reflow machine and a computerized line control and reporting system, points out Walter Rizzi, a Dynapert vice president.

Broad-range vendors currently have and will probably keep their hefty advantage with high-volume customers, say analysts. But the question of which way the medium-volume and small-volume customers will sway is still open. In the medium-volume range, Cincinnati Microwave, for example, preferred to integrate its multivendor line itself. But Iomega, which also installed a fully automated line, only looked at broad-range vendors "that can supply a line from A to Z," according to Rowland.

Smaller volume customers, on the other hand, are more cost sensitive when buying equipment and less likely to be concerned about integration. Analysts expect the newer, specialized vendors to do particularly

SMT boards go for that all-over tan

In the area of SMT soldering systems, the overwhelming trend is toward infrared (IR) reflow, which utilizes IR heating elements to create a multizone oven for heating the solder paste on the circuit board. IR reflow is cleaner, less expensive and potentially less damaging to components than vapor phase reflow, the previous standard, which passes a hot Freon-based vapor over the board. And with improvements to IR reflow equipment, previous obstacles to IR's growth, such as the problem of uneven heating, have been removed. According to Howard Miller, Universal Instruments Corp.'s SMT marketing manager, most customers are now choosing IR, a "dramatic switch over," from two years ago.

Vapor phase still has uses, primarily for military applications, which are denser and require much more energy to heat the board uniformly, according to James Blankenhorn, president of SMT Plus Inc., a San Jose consulting firm.

According to Charles-Henri Mangin of Ceeris International, a market consultant, Vitronics Corp., an IR pioneer, is No. 1 in market share in reflow systems. Vitronics is followed by other vendors such as Dynapert, Radiant Technology Corp., of Cerritos, Calif., and the broad-range SMT makers. □

Gene Mopsik

well in this segment. The medium-volume segment, meanwhile, will probably be the main battleground for specialized and broad-range vendors.

American broad-range SMT vendors are bracing for another contest, this time with the Japanese. Japanese companies have developed a stronghold in the high-volume segment of the market, where expertise in producing consumer products has given them a rich selection of high-speed products and a spotless reputation for reliability. "They have five to 10 years more experience than we do" in building high-volume SMT lines, says Mangin.

While the Japanese mainly developed their SMT production expertise in house, American SMT vendors built their product lines by concentrating on the typical types of companies found in the United States: medium- and low-volume electronic equipment makers, who, rather than being concerned about speed, are more interested in flexibility, or the line's ability to allow quick reconfigurations and to handle a wide range of components.

But as key U.S., European and Pacific Rim customers finally take SMT into high-volume production, Universal and Dynapert, the major U.S. broad-range vendors, have become concerned about losing this high-end business and are expanding their offerings into the high end.

Chip shooters

The main weapon is the pick-and-place machine, which often accounts for half of the cost of an SMT production line and is regarded by many as the most critical item in determining the line's throughput and flexibility. Japanese high-speed "chip-shooters," for example, plunk down resistors and capacitors in excess of 10,000 components per hour. The fastest machines from Universal and Dynapert, in contrast, had ratings of 4,500 to 6,000 components per hour.

Within the last year, however, both Universal and Dynapert have introduced new high-end pick-and-place machines that they rate at 12,000 to 14,000 placements per hour. And more new high-end products are on the way.

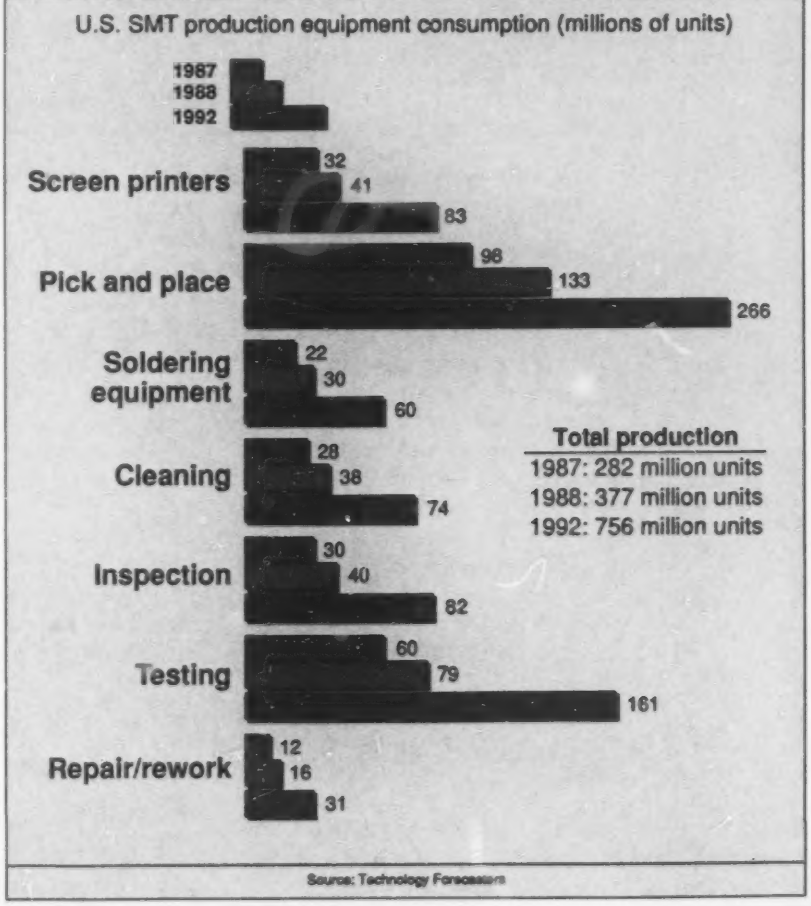
Meanwhile, Japanese companies are trespassing into the sacred territory of Universal and Dynapert: high product mix and high-flexibility accounts. The pick-and-place machine is, again, the key item. Many Japanese pick-and-place machines accomodate a limited range and number of component inputs and are time-consuming to reconfigure. American machines, in contrast, allow more inventory to be placed on the machine at one time and are more easily reconfigured to accommodate different boards.

Both Universal and Dynapert have introduced high-end pick-and-place machines that they rate at up to 14,000 component placements per hour

Prospects for the Japanese to make a successful crossing into high-mix, medium volume and lower volume accounts are still uncertain. Japanese companies such as Fuji will be introducing new, flexible machines to the U.S. market in 1988, according to Fuji America's Yamaguchi. Universal's Roth admits concern about the Japanese, but is confident about the strength of his company's technology and customer partnerships.

Likewise, no one can say if U.S. production equipment makers will succeed in grabbing a large share of the high-volume market. Consultant Mangin does not think so. "I think the Japanese have more experience," he says. However, Roth believes that flexibility may win the contest for high-volume accounts. The Universal executive notes that the needs of small-, medium- and large-volume customers are "melding together. Even people who produce high volumes want to produce it in a just-in-time fashion. They want to run only those particular items ordered that day." □

Here's why SMT production equipment makers are flush with orders



Source: Technology Forecasters

COMMUNICATIONS

Motorola and NEC gear up for car phone clash in Europe

Their joint domination of Europe's cellular phone market could end with a 1991 debut of standards for digital cellular networks

By Jack Gee

Man the defenses, Motorola! To your battle stations, NEC! Your commanding positions in Europe's mobile communications market are under attack. European manufacturers are preparing to storm a citadel which, until now, has been dominated by the United States and Japanese giants. They intend to capture a booming business for car phones, portables, pagers and private radio systems.

This challenge is a top priority for the U.S. and Japanese manufacturers. They do not intend to be caught unprepared in 1991, when 13 European countries introduce cellular radio standards that enable the same equipment to be used from one end of the continent to the other. But they will have to contend with a more belligerent type of European competition than before.

"The introduction of pan-European standards could offer new opportunities to outsiders," says Edward M.A. Mier, director of the European Telecommunications and Computer Division at Dataquest Inc. "With only one set of standards to cope with, NEC Corp. could flood Europe with low-priced cellular handsets," Mier adds.

Until now, the use of analog technology has hampered cellular radio's development. Equipment in use varies from one country to another. When a motorist drives only half a mile from France over the river Rhine, his car phone will sink into sulky silence on the German side. As travelers cross Europe's borders, except those within Scandinavia, they suddenly find they can make calls only if they use locally-made phones.

All that will change with the introduction of a pan-European digital cellular network. Within three years, customers will be able to use their cellular phones throughout most of Europe. The United States is likely to have 2.6 million cellular telephones in use by 1990. Europe, which currently musters about 500,000 users, is expected to field 3.3 million in 10 years, according to Communications and Information Technology (CIT) Research, a British communications company.

ALCATEL'S PIERRE SUARD: plans to make his consortium a major actor in Europe

With 310,000 subscribers, Scandinavia's Nordic Mobile Telephone (NMT) network, for which Sweden's L.M. Ericsson and Finland's Nokia both supply systems and telephones, groups the biggest number of users in the world. Nokia's electronics division, Mobira, has already driven its way into the U.S. market with mobile phones that are made in South Korea under a joint venture with Tandy Corp. and distributed through Radio Shack stores.

Britain now has 150,000 subscribers for a much larger population than Sweden, which it recently overtook to become the biggest European market for cell phones. Britain is also the only country in Europe with two competing networks, Cellnet and Vodafone. Dataquest's Mier explains: "By deregulating its telecommunications industry, Britain has given itself a head start in the cellular business."

Without foreign equipment, the British market for mobile telephone equipment could never have grown at its present fast rate. Virtually all the basic technology for setting up cellular coverage has come from Ericsson, supplier of the Racal Vodafone network, and Motorola Inc., which has established the rival Cellnet system. Investment of around $360 million has probably been shared equally by these two suppliers.

France, with only 30,000 radio phone subscribers, still lacks a fully cellular service. But, under a strategy to slowly deregulate some sectors of its telecommunications environment, the government has opened up the market for the radio and car phone. Early last year, Telecommunications Minister Gerard Longuet gave the go-ahead to the state-controlled telecom authority — recently renamed France Telecom — to team up with Matra, the defense and electronics group, in the cellular phone business. In December, a rival

consortium was allowed to compete. Headed by Compagnie Générale des Eaux, a large private water distribution group, it includes Alcatel, the French-controlled telecom concern, and Finland's Nokia.

The French announcement followed a rash of other European alliances in radio phone design, manufacturing and marketing in readiness for the horizon of 1991. Before joining Compagnie Générale des Eaux, Alcatel had already teamed up with AEG AG of West Germany and Nokia in another consortium. Philippe Glotin, managing director of Alcatel's radio and telephone division, says: "Together, we shall spend about $100 million on research and development. We have to start now. When the market is fully opened, the competition is going to be very intense indeed." Pierre Suard, chairman of Alcatel, comments: "Our three firms could make this consortium one of the major actors to address the mobile phone market."

In Britain, Racal Electronics Plc, which owns the Vodafone cellular network, has joined The Plessey Company Plc to create a new company, Orbitel Mobile Communications. Ericsson has also signed on with Orbitel, which is considering whether to adapt System X, the digital central office switch developed by Plessey and Britain's General Electric Co., for the cellular market. Cellnet, the competing British cellular network owned by British Telecom and Securicor, a British armored-car security company, is talking to European telephone operators about exchanging stakes in each other's networks.

In another alliance, Philips Kommunikations Industrie AG, a German subsidiary of the Netherlands-based group, and two German concerns, Robert Bosch GmbH with its offshoot Ant Nachrichtentechnik GmbH, have agreed to develop their own cellular technology in readiness for Europe's 1991 deadline.

Until a year ago, Germans waiting to put a mobile phone in their Mercedes were unlucky compared with Britons making the same plans for their Bentleys or Scandinavians for their Volvos. "But now we are gearing up to meet requirements," says Josef Kedaj, director of Public Mobile Communications at the Bundespost, the state-controlled telecom and postal body. West Germany's Siemens and Sweden's Ericsson are working together on a new generation of mobile phones which they claim will tie Scandinavia and western Europe into a seamless communications system. But meanwhile, with only 52,000 users, Germany has the smallest network in Europe.

So far, U.S. and Japanese suppliers are absent from these alliances. "We Europeans have to be careful," a senior executive of one of Europe's biggest electronics groups says. "If we let Motorola or NEC in, they will gobble us up alive."

In contrast, all the European cellular groups are keen to have Ericsson as a partner. Dataquest's Mier says: "The pan-European cellular standards will be based on those of Scandinavia's NMT network, for which Ericsson has provided the basic technology. So it's natural for everybody to be courting the Swedish firm."

While Dataquest estimates the 1990 value of the U.S. cellular market at almost $5 billion, spending on equipment and services in Europe will reach $4 billion, according to CIT, the British research organization. Europe has lost precious time in establishing standard processes for its continent-wide network.

Value-added services are a key marketing gambit in all 13 European countries which are gearing up for the full scale arrival of the cellular phone. "More and more people need to transmit or receive data while they are on the move," says Peter Waller, managing director of Britain's Cellnet network. Maurice Remy, managing director of France's Matra Communication, remarks: "Value-added services are going to be a major market. All business users of mobile phones will soon have a need for them." □

European cellular phone market

Source: Communications and Information Technology Research

Motorola won't be left out

Motorola Inc. is determined not to miss the big opportunity offered by Europe's 1991 deadline for the advent of a continent-wide cellular system. It is already staking out its claim.

Neck and neck with NEC, Motorola has captured more than one-quarter of sales in Britain's cut-throat market for handset equipment. But it is being challenged by Japan's National Panasonic in the up-market product range. Finland's Nokia Mobira and Canada's Novatel are also important suppliers.

Motorola and NEC Corp. owe their powerful positions in the handset market to their strength in semiconductor technology and the special emphasis which they have given to telecommunications devices. NEC, which has until now imported its equipment, plans to invest in a new plant in Telford, England. Motorola assembles handsets at Stotfold, England. It also employs about 100 people at its Basingstoke, England, network facility.

Don Burns, managing director of Motorola's Communications Division in Britain, says: "We are planning steady expansion. This could double the 500 people we have working on cellular products to 1,000 over the next four years." □

OPERATING SYSTEMS

Painting Unix blue: How IBM stoops to conquer

The Unix operating system is supposed to make users like GM and the U.S. government supplier-independent. IBM has other ideas

By David Card

Unix from IBM? The idea seems self-contradictory. The major benefit of the industry-standard but AT&T-owned Unix operating system is that it frees software from hardware dependence. That is, software written for Unix is easily moved between computers from different suppliers. Everybody knows that account control is the IBM way.

But there it is — IBM launching a serious Unix effort. Only it's not Unix, it's AIX, IBM's pet version. And that makes a whole Blue world of difference.

AIX, for Advanced Interactive Executive, was developed under the auspices of IBM's Austin, Texas, Advanced Engineering Systems (AES) business unit. That unit — which last summer moved under the control of the Entry Systems Division, home of IBM's personal computers — is also the birthplace of IBM's much-maligned technical workstation, the RT PC. In fact, AIX and the RT go hand in hand as each is optimized to enhance the performance of the other.

At a press conference in February, some IBM heavyweights, including J.L. "Jerry" Latta, the group director of Technology Computing Systems, and William Lowe, president of Entry Systems, pledged renewed support for AIX and "RT follow-ons." They said IBM is adding over 1,200 marketing representatives and systems engineers for the combo this year, and at least that many again in 1989. Lowe said that the money and people going into the pair equaled that which IBM is expending on its new personal computer line, the Personal System/2 series.

As yet, AIX has only tenuous ties to Systems Application Architecture, IBM's grand scheme to tie together its disparate hardware, software and operating systems. SAA is a long-term project to ensure that any software will run on any IBM hardware, and look the same to the user. If SAA sounds a little like Unix, it should. Their goals are similar, with the key exception being that SAA works only in the Blue domain.

And so far, AIX only runs on the RT and the high-end models of IBM's PS/2 family. But IBM has plans to eventually move the operating system up to its mainframes and downward to its entry-level PS/2s.

Despite that, many IBM competitors, analysts and third-party software developers remain skeptical about IBM's commitment to a standard operating system. Many think IBM is supporting Unix begrudgingly. "I think they've been dragged kicking and screaming into Unix," says E. Joseph Zemke, president of IBM mainframe rival, Amdahl Corp. "But IBM knows that it's not going away."

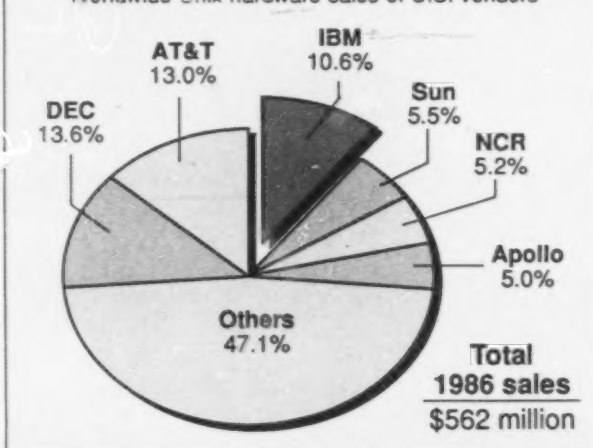
Unix certainly is not going away. Framingham, Massachusetts-based market researcher International Data Corp. forecasts that hardware running Unix will account for 22% of the computer dollars sold by U.S. vendors in 1991. That's up from only 6% in 1986, and means that Unix will rival the market shares of IBM's mainframe and PC operating systems.

The people working on AIX and the RT are at AES under vice president and general manager Andrew Heller. Heller, an IBM Fellow, is something of a maverick by Blue-suit standards. His favorite footware is a pair of cowboy boots made of lizard skin — "desert rat" in Austinese — and he's proud of the fact he wasn't fired for showing up at a management meeting on a motorcycle.

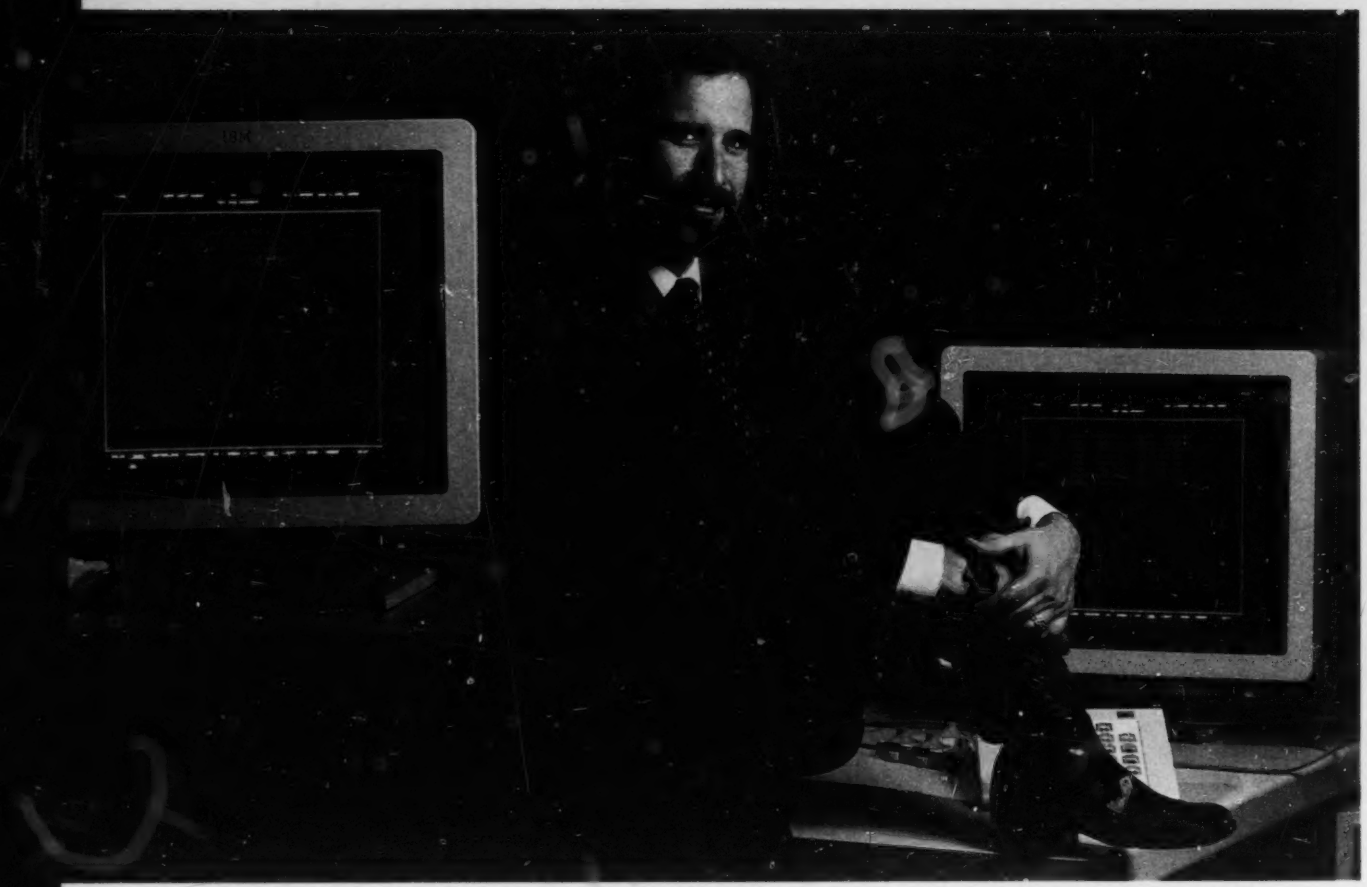
Heller won't say how big

IBM is already a leading Unix player

Worldwide Unix hardware sales of U.S. vendors



Source: International Data Corp.



IBM's ANDREW HELLER: "We're providing a Unix based on AIX that we think is the leading-edge system out there today"

the operation at Austin is, except that "it's a *big* division. I have a lot of people." Plus, programming chores are parceled out to other IBM divisions as well as to outside contractors like Interactive Systems Corp. and Locus Computing Corp., two Santa Monica, Calif., companies that have worked on AIX.

"The philosophy we have in Unix is quite simple," Heller says. "We just want to provide the widest range, from top to bottom, of price/performance offerings, the best operating system, and, we believe with our RISC follow-on products, the absolute best price/performance you can get anywhere in the industry. That ought to be enough to get people's attention."

Heller describes Unix's most influential feature: "Portability, an open system interface, is the strength in this. It's the strength that's allowing and driving the industry to be the most creative segment of the entire computer industry." Uncommon words from an IBM employee, even a maverick.

When it is pointed out that vendor independence and transportability fly in the face of traditional IBM marketing techniques, Heller forms this answer: "We're providing a Unix based on AIX that we think is the leading-edge system out there today. It ties to our SAA systems as no other Unix system does. It offers more capability than any other Unix. And it's an industrial-grade system. Given those three things, we believe we offer a value-added that no on else is going to offer.

If SAA sounds a little like Unix, it should. Their goals are similar, with one key exception — SAA works only in the Blue domain

"Now the fact is, a large number of applications are being generated by a large number of vendors who are going to go to Unix with or without us. If we provide the best Unix, they'll start with us. If we ignore them, they're going to keep on going in what is becoming a very interesting segment of the business."

The vendors developing those applications are not exactly lining up in Austin. In fact, in the area of computer-aided design and engineering (CAD/CAE), a stronghold of Unix software, they're walking away. The PC CAD leader, Autodesk Inc., built its business on the IBM PC, and now offers software for Unix workstations. But Autodesk quietly dropped a package that ran on the RT. Similarly, Valid Logic Systems Inc. crowed about its IBM efforts — until it teamed up with Digital Equipment Corp. and Sun Microsystems Inc.

Heller says IBM will work closely with "specific vendors," mentioning Dassault Systemes, the French company whose 3D CAD package IBM resells. "There will be some applications that the Advanced Systems Development Division, which is our new programming division, will either find for us or build for us," Heller says. "But in the Unix world, our intent really has been to find the best and try to work with it."

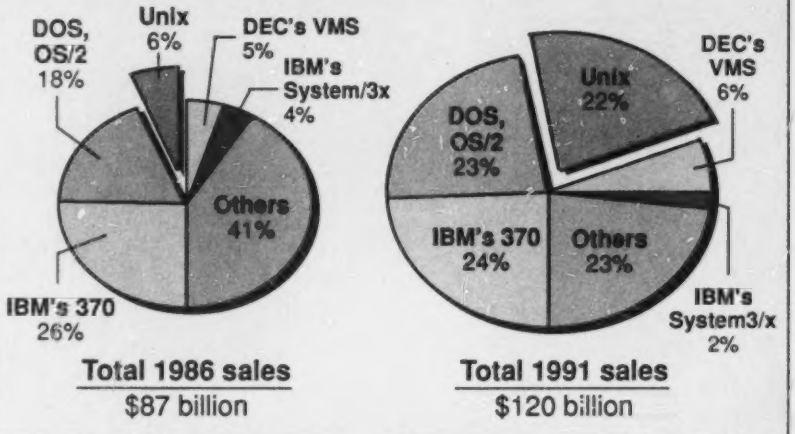
Private strategy?

Originally, IBM supplied Microsoft Corp.'s Unix, called Xenix, for its PCs. In 1985, IBM was the leading shipper of Xenix, according to Paul Sribhibhadh, director for marketing for Microsoft's Xenix business unit. "We found IBM wasn't focusing on

C. Thatcher

Why does IBM care? Because Unix will be a major market, worth over $25 billion by 1991

Worldwide hardware sales of U.S. vendors, by operating system



Source: International Data Corp.

Xenix," he sniffs. "Now it's AIX. That'll be interesting." IBM still supports Xenix on its 16-bit PS/2 models, but has otherwise lost interest in it.

Heller says IBM dumped Xenix for purely technical reasons. AIX is "going across a much wider set of platforms than Xenix was targeted to," Heller says. "It's a much more hardened, industrial-grade system, and we have put some rather important, unique IBM features in it."

Some say IBM has included too many proprietary features. John Logan, director of research for The Yankee Group, a Boston consultancy, sees AIX as "an excellent contingency plan" for SAA, should that monstrous task take too long. More importantly, however, he thinks AIX is a strong version of Unix but is "really proprietary to IBM — AIX is only 49% Unix."

Potentially, the "proprietariness" of AIX could work in IBM's favor. Those software developers that Heller wants to write for IBM first could find themselves almost locked into AIX. Although other Unix software could move into the IBM AIX domain, any optimizations written for AIX could not move out.

But Heller says that even IBM can't mess with the standard. "You've got to remember that even if you don't like something in the Unix standard interface, you've just got to make it run better and cleaner than anyone else, but you can't go change it. You can add to it, but you can't change it," he says.

As Heller says, once the Unix interface standards are met, software moves easily between Unix flavors. And Heller maintains that IBM will keep things open. "In the sense that we can add things on, if they become useful to a large number of people, then we'll try to push them and sponsor them to be part of the standard," he says.

In fact, IBM is active in the efforts of standards bodies like the Institute of Electrical and Electronic Engineers (IEEE), which is working on Posix, a set of conformance rules to make sure everyone's Unix matches up. But IBM is very particular about which standards it supports. For instance, IBM ignores AT&T's System V interface standard (SVID). SVID actually does not specify Unix, but its close resemblance to AT&T's implementation of the operating system caused Digital Equipment Corp. to abandon a $4 billion Air Force contract bid that specified SVID. And IBM is not a member of the European Unix consortium, X/Open, even though DEC and AT&T are members. But IBM conspicuously offered its own Unix-conformance testing system to the National Bureau of Standards.

Kathleen Comiskey, a Unix specialist at International Data, says IBM's participation in committees is hardly altruistic. "It's definitely to manipulate them, to see things go as

Where goes Unix, there goes RISC

It seems that if you believe in Unix, you have to believe in RISC, or vice versa. The IBM-invented technology for reduced instruction set computing goes hand in hand with Unix — IBM's homegrown Unix was developed for its RISC workstation.

"There's nothing in Unix that inherently makes it better to run on RISC versus non-RISC," says IBM's resident RISC/Unix guru, Andrew Heller, vice president of IBM's Advanced Engineering Systems business unit. "Now, there's something in RISC that inherently makes it highly competitive. RISC, we believe, on a silicon basis, has a tremendous advantage over non-RISC architectures. And if one were to say: Gee, Unix is potentially a commodity-oriented thing, [then] price/performance is very visible."

Last summer, the RISC team was moved into IBM's Entry Systems Division, home of its personal computer efforts. IBM is starting to market its RISC machine aggressively as a small commercial multiuser system. And Heller likes to point out that there is a RISC chip in the channel system of one of IBM's mainframes. Could that spell conflict for IBM's non-RISC midsized or mainframe models? Heller replies: "Would IBM try to manage the performance that I got out of my RISC systems? The answer is: Absolutely not. My orders are to build them as fast and as inexpensively as possible."

Sun Microsystems Inc.'s CEO Scott McNealy aims to put his "Sparc" RISC chip into computers ranging in price from $1,000 to $1 million, or in "Sparcintoshes to Sparcframes." And watch out for Amdahl Corp., which clones IBM mainframes. Amdahl just so happens to be half owned by Fujitsu Ltd., the company that makes most of Sun's Sparcs, and it just signed a deal with Sun to work jointly on the next version of Unix. Not to mention that AT&T is Amdahl's biggest customer. Amdahl president E. Joseph Zemke says he's taking a long, hard look at Sun's chip for future projects. □

JUNE IN

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much their way as they can." Adds Robert Ackerman, X/Open's chief marketing officer: "IBM says X/Open duplicates the work of the standards bodies. They're being snooty about it." IBM says it can't partcipate in a group that commits to product development before standards have been established.

John Williams, senior manufacturing project engineer at General Motors Corp., thinks IBM is waiting for results from the IEEE before making a major Unix move. Williams is on GM's Advanced Manufacturing Engineering project, headquartered in Pontiac, Mich., "My private suspicion," says Williams, "is that when Posix is set and everybody is out from under AT&T, then we'll see something," from IBM.

Others think IBM is simply dragging its feet while others test the waters. "They need other people to legitimize a market for them," says Heidi Monaco, vice president of software developer Unify Corp., and an IBM alumna. She thinks IBM's mainframe Unix efforts might pick up if arch rival Amdahl does well. While Amdahl mainframes run IBM software, president Zemke credits 15% of the company's 1987 sales to Unix.

But Paul Cubbage, a Unix watcher at San Jose market research firm Dataquest Inc., warns competitors not to dismiss IBM easily. "I would expect IBM to be one of the major players — in the top five in the 90s," Cubbage says. "If the market is big enough to get their attention and make them spend enough, the potential is there that they could be the market leader." □

A competitor's eye view of IBM's Unix

Amdahl Corp.
"I always take IBM seriously. It's only a question of time before they provide better Unix solutions."
E. Joseph Zemke, president

Sun Microsystems Inc.
"They're trying to do a proprietary environment. They don't believe in open systems . . . I would rather be competing against IBM on a Unix-to-Unix basis than on their own terms."
Scott McNealy, CEO

Hewlett-Packard Co.
"It's their way of saying: We agree. They only offer Unix as a last resort."
Douglas Speng, general manager, commercial systems

Prime Computer Inc.
"IBM is still big enough that IBM can do what IBM wants to."
Leonard Halio, vice president

Unisys Corp.
"The RT PC is isolated; it's a little wild baby . . . AIX is not part of SAA, even . . . If they are supporting Unix in Europe, it's well hidden."
Guido Vanherberghen, Unix-products manager, Europe and Africa

Altos Computer Systems
"I think it's a place-keeper. IBM intends it to say: We will not be excluded from government procurements . . . Is it really and truly marketed, or an overall strategy? The thing you have to consider is where their mainstream is."
Russell Aldrich, director for sytems software marketing

Gould Inc.
"IBM is probably going to go to Unix before DEC does. They don't have an overall operating system strategy that fits over all their hardware . . . Unix could do some of that for them . . . "
Douglas Beard, senior director for marketing, Computer Systems Division

Pyramid Technology Corp.
"In talking to VARs, I don't know if it divides up one-third, one-third, one-third, but there is an IBM world, a DEC world and a Unix world . . . For IBM, Unix is a defensive move. They'll keep it in the workstation marketplace for a fairly long period of time . . . "
Nick Tuttle, vice president for marketing

Apollo Computer Inc.
"They have a very aggressive group down in Austin . . . They have to work within the conservativeness of the company, but the potential is there . . . Anybody who writes them out of it at this point in time is foolish."
Mark Hatch, Domain products marketing manager

PERIPHERALS

Control Data cashes in on a captive operation

CDC is turning its internal expertise in thin film heads for disk drives into a thriving OEM business

For Control Data Corp., making semiconductors that fly is both an old and a new business.

For several years the Minneapolis-based company has made its own disk drive thin film read-write heads, semiconductors which replace traditional composite ferrite heads. These semiconductors "fly" about 10 millionths of an inch above a disk because they are grooved on the bottom to create the same type of aerodynamic "lift" as a wing gives an airplane.

But since 1986, CDC has moved into the original equipment manufacturer market for thin film heads, which are in demand because their output signal is superior to composite ferrite read-write heads. The stronger output signal is important because the narrower data tracks on high-capacity disks generate a weaker signal than standard-width tracks.

CDC's newfound interest in the OEM portion of the thin film head market mirrors the trend toward increased storage density on all sizes of disks, but particularly the 5.25-inch and 3.5-inch models.

While CDC doesn't disclose revenue or earnings from its thin film head business, analysts estimate that it sold about $25 million worth of thin film heads to the OEM market in 1987, while producing another $100 million worth of the heads for its own internal use.

That's a relatively small business for CDC, which had revenue of $3.3 billion in 1986. But the OEM portion represents rapid growth from 1986 OEM thin film head sales, which analysts estimate at $5 million.

The main stumbling block to the new thin film read-write head technology, however, is that it is still more expensive than the less-exotic composite ferrite head technology that relies on tiny machine-tooled magnets instead of semiconductors.

But CDC's decision to market thin film heads to the OEM market is designed to address that problem. In addition to tapping a growing market, CDC hopes to boost thin film head production in order to obtain economies of scale that should lower per-unit prices. It's a strategy not unlike the one CDC used successfully in the early 1960s, when it began OEM sales of its disk drives to competing mainframe vendors.

CDC's VICE PRESIDENT RIEGEL: "It was a dire cultural change in this division to get focused on customer requirements"

Peripheral Components International (PCI), the CDC subsidiary that handles thin film head production and sales, is much newer than the disk business. It grew out of a joint venture with Memorex Corp. in the early 1980s; CDC bought out its joint venture partner more than three years ago.

David Riegel, vice president of CDC's 5,000-employee components division, which includes PCI, says that the density requirements of smaller disks mean that thin film heads will be needed on 5.25-inch drives in the 300-megabyte to 500-megabyte range and on 3.5-inch drives with more than 100MB of storage. Thin film heads also are used on some drives using 8-, 9- and 14-inch platters, he adds.

In 1987, PCI made 3 million thin film heads and sold 20% of them to the OEM market, while 80% were used by CDC. In 1988, the company projects it will make 7 million thin film heads, and sell 40% of them to the OEM market. Peter Gove, marketing general manager of PCI, says that will give his operation "the greatest [thin film head] capacity in the industry outside of IBM."

PCI also expects to make about 5 million composite ferrite heads in 1988, but this year will mark its first venture into the OEM market with that product. Thus it is thin film heads, which have been sold to OEMs since mid-1986, to which PCI is looking for sharp sales increases this year, Riegel says.

Despite the sharp decline in the stock market in late 1987, and the resulting jitters in the business world, PCI sees no reason to reduce its sales expectations for 1988. "We've got firm purchase orders through the middle of 1988 that absolutely use our capacity," Riegel says. Adds Gove: "For the second half of the year we have high confidence in our estimates."

Riegel says his operation will benefit from a built-in multiplier factor as sales of smaller disk drives increase. While today's lower capacity 5.25-inch drives use as few as six thin film heads each, a 5.25-inch drive with a capacity of 380MB requires eight platters and 16 thin film heads, he says.

But to take advantage of a growing market, CDC has had to invest about $10 million in PCI in the last year, boosting its total investment in the subsidiary to about $60 million since 1983, Riegel says.

At the same time, PCI had to change marketing attitudes inside CDC while convincing disk drive manufacturers that it wouldn't reveal

their product plans to CDC's own drive designers.

"It was a dire cultural change in this division to get focused on customer requirements" after years of being a captive head manufacturer, Riegel says.

To win customers, he adds, "you have to be able to demonstrate to them that you manage the [disk and head] businesses separately and that there will be no information transfer, that you will protect their proprietary information."

Gove says that convincing customers PCI will honor their secrets "is the toughest challenge we've got."

Dennis Waid, an analyst with Peripheral Research Corp. of Santa Barbara, Calif., says CDC and other suppliers of thin film heads are benefiting from a shortage that is expected to continue until at least the end of 1988.

While PCI's disadvantage is that it is part of a large diverse company instead of being focused solely on heads as its competitors are, Waid says, "for the time they've been in business they've done a fairly good job." In addition to being "in the right place at the right time, [PCI] has probably got more experience in thin film heads than anybody except IBM," he says.

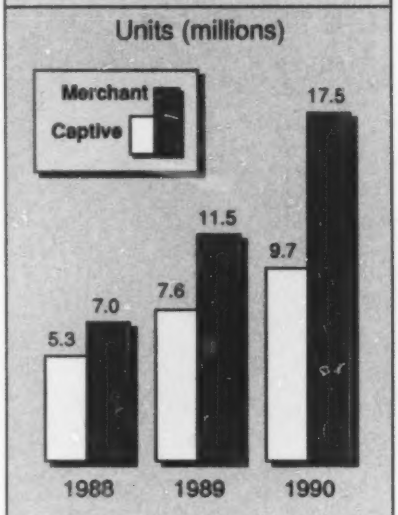
Thin film heads were used in 12.9% of the total non-IBM hard disks sold in 1987, Waid says. By 1990, that number is expected to grow to 35%. Driving that growth is the ability of thin film heads to read 30,000 to 35,000 bits per inch; and about 2,500 to 3,000 tracks per inch; compared to composite ferrite heads which can read 16,000 to 18,000 bits per inch; and about 1,300 tracks per inch.

In 1987, Waid says, CDC marketed about 33% of the $36 million worth of thin film heads sold to the OEM market (which excludes the huge internal consumption of CDC and IBM.) Competitor Read-Rite Corp. of Milpitas, Calif., had 32% of the market last year, while another contender, Applied Magnetics Corp. of Goleta, Calif., had 30%, he adds. Small manufacturers divided up the remaining 5% of the market.

The OEM market for thin film heads will reach $115 million in 1988, Waid predicts. That won't include a significant presence by the Japanese, who are heavily committed to ferrite head technology, he adds.

But Riegel says he's expecting Japanese thin film head manufacturers to expand into the U.S. market, where

OEM market for thin-film heads outpaces captive needs



Source: Peripheral Research Corp.

Panasonic and TDK have done some initial testing of the waters. "They'll be there. We expect it, and we expect that they'll be formidable competitors."

CDC won a big victory this year when Read-Rite suffered process control problems in its thin film head manufacturing and couldn't meet the needs of Maxtor Corp. of San Jose. Robert Teal, senior marketing and

The main stumbling block to the new thin film read-write technology is that it is still more expensive than composite ferrite heads

sales vice president at Maxtor, says his firm turned to PCI to take over as its main supplier, and signed a contract that will have a value of about $35 million through the middle of 1989. "I really don't know how you could do a 760MB drive without thin film technology," he adds.

Teal says Maxtor needed a vendor that could provide reliability, consistency and a relatively low cost per unit. "PCI is better positioned than other folks to provide all those parameters because of their large investment in capital equipment" and because CDC's combined OEM and internal production helps reduce the cost per head, he says.

Riegel agreed. "We took advantage of supply constraints that occurred" in early 1987, he says. "I think production will catch up with demand, but . . . it's not clear that production will catch up in 1988."

Dundas Flaherty, chief financial officer for Micropolis Corp. of Chatsworth, Calif., says there is indeed "a temporary insufficiency of supply of thin film heads, but it's hard to say when supply will catch up with demand." Micropolis also is a PCI customer, he says, "but I hesitate to say more than that."

But Riegel says one problem facing the business is that the thin film heads still cost more than the insect-sized composite ferrite heads made with machine tools. As a result, the OEM market for thin film heads isn't as big as it might be, he adds.

While Gove projected that prices will go down as production volume increases, by 1989 thin film heads still will cost about $13 each in quantities of hundreds of thousands. Waid says that's more expensive than composite ferrite heads, which in late 1987 cost from $8 to $10 each in similar quantities.

Waid says thin film heads remain more expensive because of the unique technical problems involved with making them fly, such a short distance above the disk, 10 millionths of an inch compared to 12 millionths to 16 millionths for a composite ferrite head. The machining process that is used to give the finished semiconductors wing-like undersides isn't perfected, he says, and as many as half the thin film heads may be so flawed that they must be discarded.

That's far below the yields typically obtained in the semiconductor-manufacturing process, and means that the machining part of thin film head production acts as a bottleneck in obtaining the higher yields that could result in lower prices, Waid says. The reduced yields result in higher prices for the usable thin film heads, he adds.

"Theoretically, thin film head design . . . allows you to produce lots of them once your [semiconductor] manufacturing process is up," he adds. "But the problem is that the [machining] yields have never been high enough that they paid off."

Adds Riegel: "The yield challenge is always there."

STEVE GROSS

Skip the front page, and ignore recession talk

They make you lose sight of what's important: That the electronics industry is outperforming the economy again

By Alberto Socolovsky

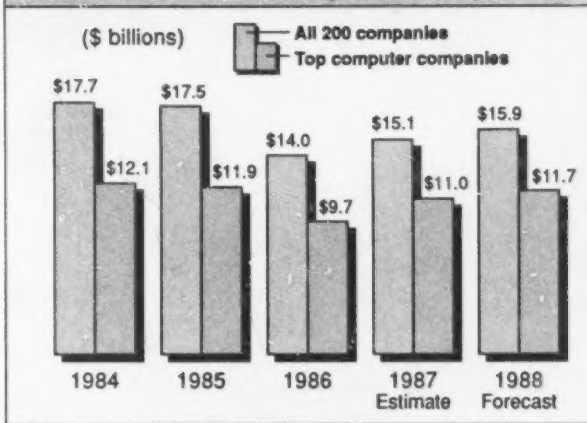
We usually report in the pages of ELECTRONIC BUSINESS, most often interpret, generally encourage, but rarely admonish. This is the time for a gentle, but not less sad, admonition: When reading *The Wall Street Journal*, that excellent business daily, skip the front page. Those front page stories on the odds for a recession are getting to you.

We can tell that from a recent survey of our readers' plans for capital investment in 1988. Our study, conducted right after the stock market crash of last October, reveals the negative impact the crash had, even when most of the electronics industry was wrapping up 1987 on a very upbeat trend. While the psychological effects of the crash are slowly wearing off, they rekindle every time you see a story quoting this or that economist's opinion on the likelihood for an economic recession. Even if there is one, the electronics industry will outperform it. But you will miss the opportunities that a growing industry will offer, if recession talk dissuades you from gearing up your company for international competition.

Our survey reveals that our readers plan to invest about 5% more dollars this year than last, but they don't plan an increase in investment as a percentage of sales. That is, even after the crash, you plan for 1988 as a year of more sales — why not, then, for more investment? There is, however, an encouraging trend in the survey. Most of the investment, 74%, will be in the United States, and primarily — 56% — for manufacturing equipment. Of the investment abroad, most will be in Mexico, followed by Singapore, Western Europe, Taiwan and Malaysia.

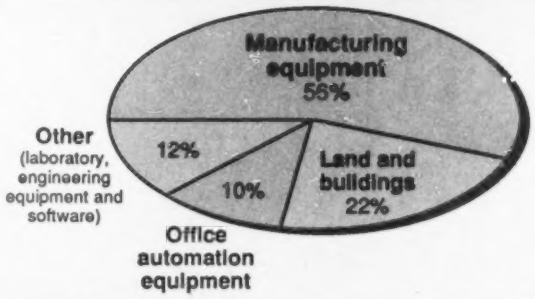
To be sure, many American electronics companies, particularly the computer companies that, like Digital Equipment Corp., Hewlett-Packard Co. and IBM, are committed to manufacturing. They have kept up their investment and will reap the rewards in increased international competitiveness. It's just that their example is not spreading fast enough, even though it is far more instructive and enlightening than all the front page articles about an economics doomsday. □

Capital investment by the top 200 electronics and computer companies



Source: The ELECTRONIC BUSINESS 200

Manufacturing equipment gets most of the 1988 investment



Source: ELECTRONIC BUSINESS survey

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

MAY 1, 1988

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Charles Sporck, president of National Semiconductor

Electronic Business

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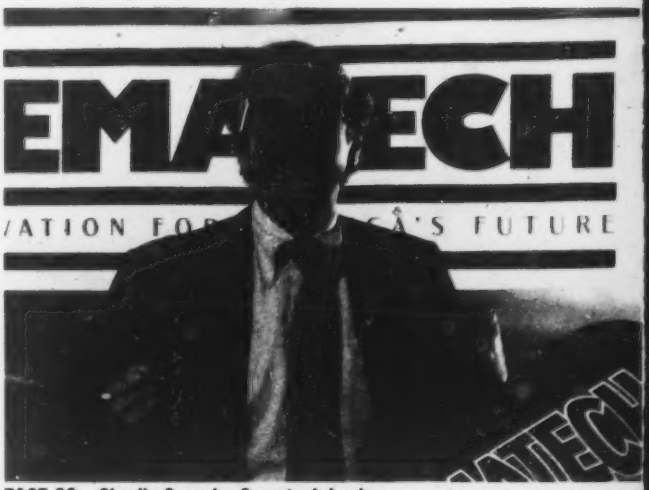
Throughout the past year, chairman Charles E. Sporck has been an active cheerleader for Sematech. He has aggressively lobbied lawmakers and vigorously recruited new members. But critics question whether the federally assisted consortium is really worth its annual $250 million budget. Will Sematech save the U.S. chip industry? Or will it become a massive boondoggle?



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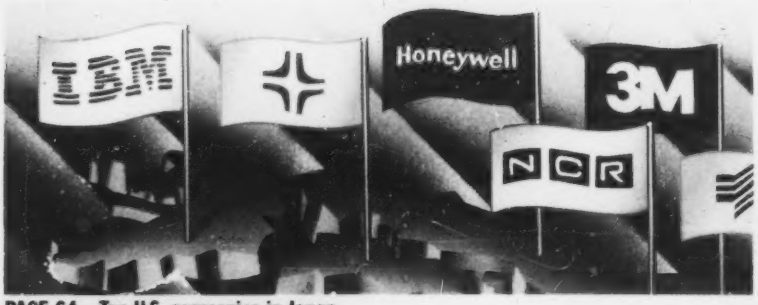

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Life in the fast lane

Each year, ELECTRONIC BUSINESS tracks the fastest growing companies in the electronics industry. Compiled by senior editor Linda Stallmann, our financial analyst, the ranking tells me more about where technology is headed in this country than any other indicator I know.

Based on annual reports and other public documents, the article accompanying this year's list analyzes revenue figures for publicly held electronics companies by computing five-year compounded average growth. As this year's article — by associate editor Bruce Rayner — points out, CAE and workstation companies were clearly among the biggest gainers from 1982 to 1987. But, I suppose, that's not all that surprising, if you really think about it. After all, where technology goes, bucks will follow.

Heading some of the fastest growing companies are, from left: Daisy's Friedmann; Apollo's Vanderslice; Mentor's Bruggere; and Sun's McNealy

Not just Sematech semantics

We have no doubt whatsoever that most of our readers will have no trouble recognizing the unabashed Cheerleader for Competitiveness on our cover. The man with the megaphone is, indeed, none other than Charlie Sporck, the driving force behind both National Semiconductor and Sematech, the controversial industry consortium aimed at reviving America's semiconductor industry.

But, as the cover story by senior editor Alden Hayashi and associate editor Valerie Rice ably points out, the growing controversy over Sematech is not just a question of semantics. It's a "do or die" situation today in the roller-coaster microelectronics industry. And in this series of articles, Alden and Valerie take a long hard look at the political and economic implications of Sematech's very existence.

Check out our redesign

If you're a longtime subscriber to ELECTRONIC BUSINESS, you may have noticed that our art department has redesigned the magazine — starting with the cover and ending with editorial director Alberto Socolovsky's "Viewpoint" on the final page. The purpose of the new format is primarily to provide our readers with quicker and easier access to business information.

Our late publisher, J. Chat Kelly — who died Feb. 13 of lymphatic cancer — was the driving force behind the decision to give the magazine a more modern look. This issue and the entire redesign is dedicated to his memory.

AL FURST

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BPA ABP

Pols blast away at the Strategic Defense Initiative

Billion dollar budget cuts are wreaking havoc on the president's plan to deploy space-based weaponry

From its inception, President Reagan's Strategic Defense Initiative (SDI) captured defense contractors' attention. Excited about the prospect of a $5 billion to $6 billion a year market for ballistic missile defense research and development, firms raced to get a piece of the action. Now, five years later, contractors and Pentagon officials worry that "Star Wars" is losing steam.

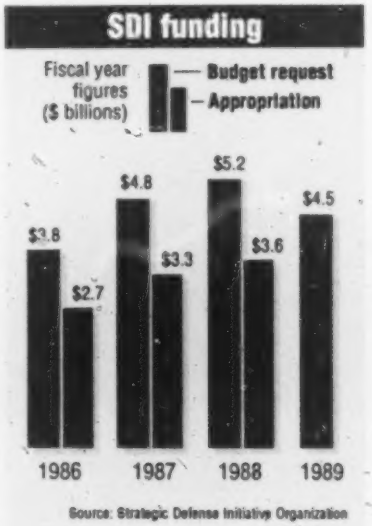
The president's fiscal 1989 budget requested only $4.5 billion in SDI funding for the year beginning Oct. 1, 1988 — $700,000 less than the amount sought by the Strategic Defense Initiative Organization (SDIO). The administration pared their SDI and other defense appropriations in its bid to present an uncontroversial election-year budget. Making matters worse for contractors, Congress is expected to further pare appropriations. For fiscal 1988, Congress limited SDI spending to $3.6 billion, about one-third less than the president's request of $5.2 billion. "When you take out that amount of money, a lot of programs are bound to get hurt," says Col. Garry A. Schnelzer, SDI acting deputy for technology.

As a result, cuts have been made across the board, although some programs fared better than others. Many contracts have been canceled, cut back or delayed. "The new budget will probably stretch out some of our programs," says A. Julian Scott, vice president of Harris Corp.'s Government Special Programs, the group responsible for coordinating Harris' SDI efforts. Harris has 35 SDI contracts valued at about $80 million.

SDI critics and proponents alike expect SDI funding to stabilize at about $4 billion a year for the near term. For the long term, SDI spending for research and development — and possible deployment — will be determined by future administrations. "There's no question that everybody agrees on the need for research, but deployment will be decided by the administration in power in the early 1990s," says Morry H. Thorsen, vice president of advanced systems for Martin Marietta Corp.'s Astronautics Group.

John Pike, an outspoken SDI critic at the Federation of American Scientists in Washington, agrees. "We clearly need to do research to stay ahead of the Russians," according to Pike. "The question is: Do you need to spend $4 billion?" Answering his own question, Pike continues: "Probably not." He suggests spending less than $3 billion on missile defense. Pike estimates that the U.S. defense industry is five years ahead in laser and rocket interceptors; five to 10 years ahead on sensors and 10 years ahead on battle management.

Because of budget cuts, it now looks like the goal of deploying a space weapons shield in the early 1990s will, at best, be postponed a few years; and, at worst, shelved forever. Furthermore, Reagan's goal of testing antimissile weapons in space has been put on the back burner, while SDI emphasizes more ground-based testing and laboratory work.

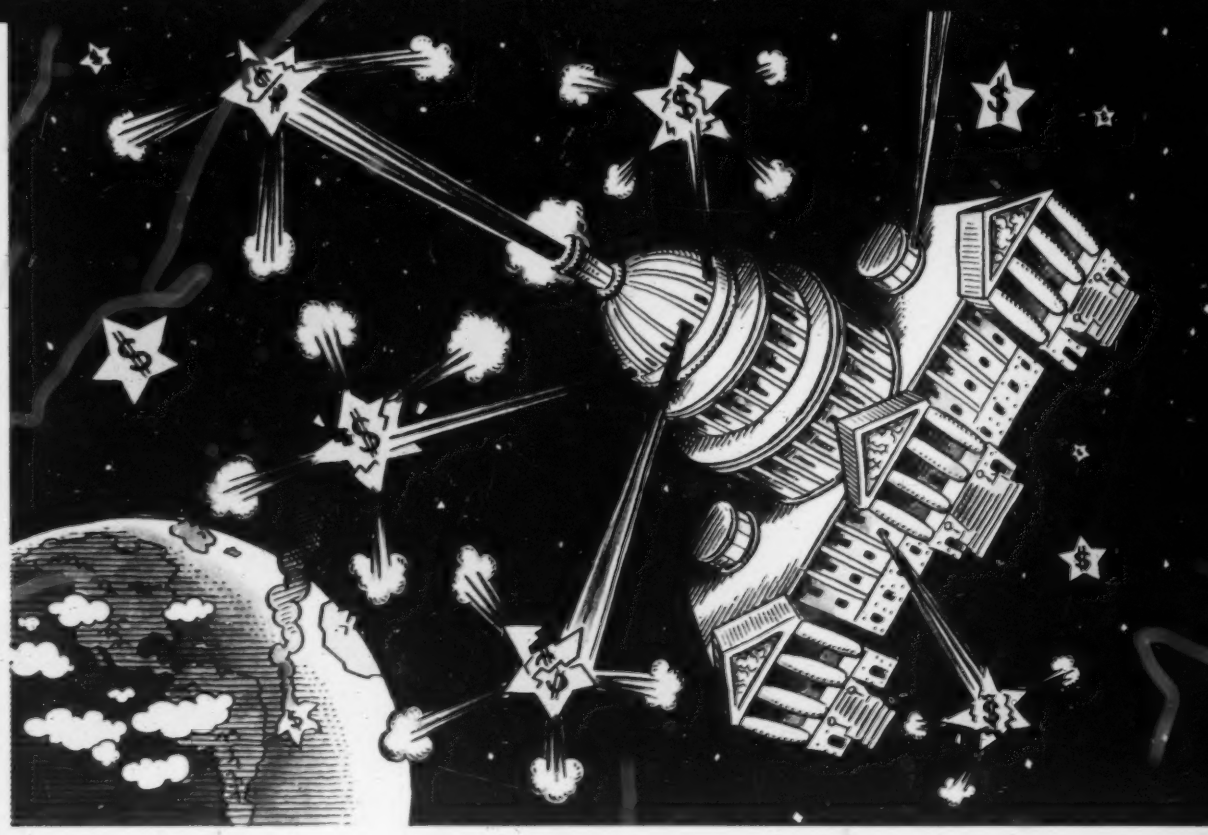


Earlier this year, for example, Martin Marietta's Information Communications Systems won a $508 million contract to test and evaluate a simulated missile defense system at a variety of test sites around the country. A week later, the Air Force canceled a $480.8 million contract with McDonnell Douglas Astronautics Co. to design, fabricate, integrate and test a space-based high-energy neutral particle beam device.

GaAs outlook

Especially hard hit by recent budget cuts are signal processing technology programs, including radiation-hardened gallium arsenide (GaAs), silicon and real-time signal processing efforts. The fiscal 1988 budget approved late last year appropriated $71.5 million for signal processing, almost half the amount Defense requested for the year and 22% below the previous year's expenditures. In 1989, further cuts are expected.

The gallium arsenide budget, cut in half from 1987 to 1988, will be slashed two-thirds in 1989 — down to $20 million from a requested $57 million in 1988. "We balanced gallium arsenide against silicon and gave priority to silicon," says Schnelzer. "We did, however, try to maintain as much as we could of gallium arsenide. These cuts significantly reduce the support activities in materials, characterization, advanced device development and a GaAs computer subsystem demonstration. Meanwhile, the microprocessor program — an analog-to-digital converter — as well as pilot production lines and some key efforts in computer-aided design of gate arrays and reliability continue, with some cutbacks. Certain follow-on efforts



Ron Barrett

in GaAs research will proceed when funds are made available.

Yields have risen dramatically at the Defense Department-sponsored pilot production lines at Rockwell International Corp.'s Seal Beach, Calif., facility and AT&T's Bell Laboratories. McDonnell Douglas, meanwhile, is also developing GaAs chips with funding from the government and other sources. "Our pilot plants are making 8I gate devices with yields of 30% to 40%," says Schnelzer. Our goal is yields above 40% and that's very achievable."

Silicon R&D expenditures, meanwhile, have been reduced about 25%. Budget cuts scaled back such efforts as the radiation-hardened VHSIC vector processor, wafer scale integration and silicon-on-insulator programs. "The efforts in radiation-hardened silicon-on-insulator have made excellent progress," says Schnelzer. "And several contracts have achieved extremely good results in radiation-hardened bulk silicon VHSIC."

Indeed, despite budget cuts, the Strategic Defense Initiative Organization is looking closely at very high-speed integrated circuit technology for supercomputers. "VHSIC chips provide the speed and efficiency that we'd like for space-based technology," says Schnelzer. Hughes, for example, is developing a five-wafer stack of chips for a three-dimensional computer. Such a computer, with stacks of wafers, "offers substantial speed improvement over standard two-dimensional computers," according to an SDI technical progress report from April 1987. "A 100- to 1,000-fold improvement can potentially be obtained through advanced electronics and packaging," the report continues. "A five-wafer stack was assembled with greater than 99% yield."

Especially hard hit by recent budget cuts are signal processing technology programs

Miniaturization is critical to SDI's success. R&D efforts are aimed "at putting a lot in very small packages," according to Schnelzer. "Memory is very important to us." SDI is building a base, ranging from 2K static random-access memories to 16K SRAMS and higher.

SDI officials contend that one of the key benefits of Star Wars R&D is the potential for commercial spin-offs. "Technology transfer is important for any federal program," says Col. James A. Ball, director of technology applications for the Strategic Defense Initiative Organization. "We must create the tools that make government sponsored data accessible to American industry." Toward this end, SDIO has started up the Technology Applications Information System, a computer-based database that includes summaries of more than 200 unclassifed SDI research programs. Available technologies range from adaptive electro-optical signal proccesors to Z-plane planer detector arrays. Further information can be obtained by calling 800-DLA-DLSC or 202-693-3008.

FDI officials contend that the program will help expand this country's technology base, arguing that NASA research over the past decade or more has spun off important technology to the commercial sector. Critics, however, counter that if there were indeed commercial payoffs, companies would already be working on the technology. Moreover, some opponents dispute the argument that NASA R&D really led to lucrative commercial spin-offs. "We didn't go to the moon to discover Tang," says Pike.

But contractors have more than Tang on their minds. With various other major defense contracts coming to an end, they need SDI business to survive and grow.

BETH KARLIN

Sales-growth speedsters: Make way for a new generation

1987 was the year the workstation came of age, with Sun Microsystems topping the list of fastest growing companies

BY BRUCE C.P. RAYNER AND BY LINDA STALLMANN

It should come as no surprise that Sun Microsystems Inc. is the top-growth electronics company for 1987. With a five-year compounded growth rate of 474%, the $537 million workstation company sets a new record in the ELECTRONIC BUSINESS survey of the 100 fastest growing companies, now in its fourth year. By most accounts, Sun is destined for the billion-dollar club by the end of 1988.

Part of the reason for Sun's stellar performance is the growth of the workstation market itself. Computer-aided engineering workstations hardly existed at the beginning of the decade, but by 1987, reports market research firm Dataquest Inc., total worldwide revenue for workstations had reached $17 billion. The other component of Sun's growth comes from the corporate commitment to industry standards and open systems: "Everybody wants them," says Joseph Roebuck, Sun's vice president for sales. This commitment has earned Sun a 33% market share in 1987, up from 20% in 1986, a gain that Roebuck characterizes as "phenomenal."

But Sun is not the only benefactor of the workstation boom: fifth-ranked Mentor Graphics Corp., maker of engineering design systems, posted record sales and profits in 1987; 12th-placed Apollo Computer Inc., one of Sun's main competitors, has had five-year compounded growth at just under 100%; and CAE vendor Daisy Systems Corp., 15th on the list, boosted sales for a five-year average of 85.7%, despite its recent slow growth and losses in both 1986 and 1987. Gerard Langeler, president of Mentor, acknowledges that demand for workstations has contributed to his company's success, but insists that software is also important. "There is no workstation market without the applications to run on them," he says.

Just because workstation makers are in a fast-paced industry does not mean they have a monopoly on growth. Software, personal computers, chips and peripherals all are represented in the top echelons of the ELECTRONIC BUSINESS growth list. In fact, when taken as an industry segment, software was the leading performer in 1987. Sales of software grew at a rate of 64.3%, while profits grew at 84.6%. Second-ranked Lotus Development Corp., maker of the 1-2-3 database program, beat the average by over five times, posting an average sales growth rate of 369%. Peripherals makers came second, with average sales growth of 47.4%.

"I think the No. 1 reason for growth," admits Q.T. Wiles, chairman of sixth-placed MiniScribe Corp., a $362 million maker of rigid disk drives, "is that we are in a fast-growing industry." Also important are good management — MiniScribe employs a divisionalized style as opposed to a functional management style — tight cost control and being market-, not technology-driven, he adds. MiniScribe was at the top of the list last year, posting 369.5% average growth.

Calling California home

One significant trend gleaned from this list is the fact that 41 of these companies call California home. The number has been slowly but steadily inching up over the years. The closest competitor is Massachusetts, with 14 resident companies. In the future,

Top 10 fastest growing companies

1987 rank	Company	Market	5-year sales growth	Fiscal 1987 sales ($ millions)
1	**Sun Microsystems**	Workstations	474.4%	$537.5
2	**Lotus Development**	PC software	369.2%	395.6
3	**AST Research**	Boards and PCs	249.5%	206.0
4	**Iomega**	Floppy disks	185.2%	89.4
5	**Mentor Graphics**	CAE systems	164.1%	221.8
6	**MiniScribe**	Rigid disks	135.1%	362.5
7	**Symbolics**	AI systems	125.0%	103.8
8	**Oracle**	Database software	121.3%	131.3
9	**LSI Logic**	Gate array chips	121.0%	262.1
10	**Wyse Technology**	Terminals and PCs	102.9%	260.0

Source: ELECTRONIC BUSINESS

Dorothy Ahle

Driven by design: Heading some of the fastest growing companies are, from left: Daisy's Norman Friedmann; Apollo's Thomas Vanderslice; Mentor's Thomas Bruggere; and Sun's Scott McNealy

look to Texas to spawn high-growth companies. *Inc. Magazine* recently ranked Austin, Texas, the fastest growing city in the United States, partly because it won the sweepstakes to woo the Sematech semiconductor industry consortium. Also, Houston has started a campaign to become the next aerospace capital of America, after Southern California.

As with most previous years, the common thread in the top-growth companies is youth. In the top 10 this year, the oldest entrant is eighth-ranked Oracle Corp., a database management software company formed a decade ago. All other companies were established in the 1980s.

In order to qualify for ELECTRONIC BUSINESS' top 100 fast-growth list, a company must have reported sales for the past six years, with 1987 sales reaching at least $80 million. Also, the company must be U.S.-based and publicly held, with at least 70% of its total sales in electronics.

The six-year sales figure criterion was the disqualifier for Compaq Computer Corp. Compaq, the second-largest business personal computer maker in the world, behind IBM, was formed in 1982 but did not start shipping product until January 1983. It broke a first-year sales record by pulling in $111 million and has not looked back since. In 1987 the company nearly doubled its 1986 revenue by selling $1.2 billion worth of computers.

Michael Swavely, Compaq's vice president for sales, puts the company's performance down to the fact that Compaq has always considered itself a large company, even as a start-up. "In our part of the industry, you have to be a large company to compete," Swavely says. For 1988, he expects the company to outpace the forecast industry growth rate of 20%.

While growth is by definition faster when the company is just starting out, there are 13 billion-dollar companies that make an appearance in the ELECTRONIC BUSINESS fastest growing 100: leading the pack is $2.7 billion Apple Computer Inc., at No. 40. Between heavy hitters Digital Equipment Corp. and Unisys Corp., it was a close call for 68th and 69th place. Both Digital and Unisys are players in the workstation market, with DEC producing its own boxes and Unisys reselling the Sun system.

Where's IBM?

One mega-company conspicuous by its absence is IBM. For the past few years, Big Blue has been steadily climbing from 88th place in 1985 to 76th place last year. But because of lagging sales growth last year, IBM's 1987 five-year growth rate fell to

9.5% for the year, down from its 1986 figure of 12%. But this slowing growth figure is deceptive. In total, IBM boosted sales by $2.96 billion last year, an enviable figure for any company that made the list.

The key to growth, say top per formers, is a combination of elements: being young means you are aggressive and that is essential; having a good distribution system means product gets to market faster; an ability to differentiate yourself from the pack technically helps in the battle for market share; a willingness to take some calculated — and some not so calculated — risks usually accelerates growth; and being in the right place at the right time always helps.

"Our growth is based on commonsense business tactics that keep the company going with a solid foundation," says Thomas Yuen, vice president for marketing and one of three founders of third-ranked AST Research Inc. Yuen has helped to guide AST from the add-in board business into a premier desktop computer systems house. Looking back on the transition period, Yuen says the biggest problem has been production capacity. "The capacity we initially forecast was way below what we can satisfy," he says.

Bernard Tse, chairman and chief executive of 10th-placed terminal maker Wyse Technology, says his strategy is no secret: "We picked a market that is enormous and tried to be very competitive." Tse claims both a cost advantage and a price advantage and "with a little bit of luck we have been able to grow very fast." But the company's luck may have limits. Seven-year-old Wyse is operating in a business that is actually shrinking, a worrisome phenomenon to a growth-oriented company. Dataquest estimates that the worldwide terminal market contracted to $3.5 billion last year, down from $3.9 billion in 1986. Still, Wyse grew its market share in 1987 from 14% to 17%, the only terminal maker to do so.

Two top-growth companies in less than robust health are Iomega Corp. and Symbolics Inc. Iomega, a maker of floppy disk drives, has reported a net loss of $36.7 million for calendar 1987 as a result of a decline in demand, substantial reduction in inventory level and slower than anticipated acceptance of the company's new 5.25 product. Symbolics, a manufacturer of symbolic processing systems for technical and artificial-intelligence workstations, reported a net loss of $25.5 million in fiscal 1987, ending June 30, and losses of $19.9 million for the first half of fiscal 1988. The company is in a restructuring mode to pare down operations.

1987's fastest-growing companies by segment

	5-year sales growth	5-year profit growth	1987 rank
Software			
Lotus Development	369.2%	NM	2
Oracle	121.3%	124.7%	8
Ashton-Tate	71.3%	109.4%	17
Microsoft	69.8%	82.9%	18
Ultimate	42.1%	36.6%	34
Cullinet Software	28.8%	NM	45
Weighted average	**64.3%**	**84.6%**	
Peripherals			
Iomega	185.2%	NM	4
MiniScribe	135.1%	NM	6
Wyse Technology	102.9%	NM	10
Seagate Technology	88.3%	82.3%	14
Archive	69.7%	NM	19
QMS	67.4%	38.5%	22
Quantum	54.6%	116.3%	25
Micropolis	54.3%	218.6%	26
Lee Data	53.0%	34.6%	27
Intelligent Systems	46.0%	NA	30
Emulex	44.9%	10.8%	31
Xidex	42.5%	NM	33
Priam	34.0%	NM	41
Peripherals (continued)			
Cipher Data Products	25.1%	12.7%	53
Applied Magnetics	18.0%	9.7%	74
Printronix	13.8%	NM	90
Key Tronic	12.0%	-34.2%	98
Weighted average	**47.4%**	**30.2%**	
Computer-based systems			
Mentor Graphics	164.1%	NM	5
Daisy Systems	85.7%	NM	15
Mark IV Industries	67.6%	72.3%	21
Intergraph	32.7%	40.0%	42
Ask Computer Systems	31.6%	24.3%	44
Data Card	26.9%	-15.2%	51
ISC Systems	22.1%	-4.2%	57
Evans & Sutherland	20.1%	8.5%	61
Recognition Equipment	18.7%	NM	72
Coherent	14.6%	NM	82
Measurex	14.0%	NM	86
Computer Consoles	13.4%	5.3%	93
Weighted average	**27.9%**	**42.7%**	

(Continued)

NA = Not available
NM = Not meaningful, company had a loss in one of the base years

1987's fastest-growing companies by segment

Computers

	5-year sales growth	5-year profit growth	1987 rank
Sun Microsystems	474.4%	NM	1
Symbolics	125.0%	NM	7
Stratus Computer	101.9%	NM	11
Apollo Computer	98.2%	134.3%	12
Kaypro	80.9%	NM	16
SCI Systems	43.8%	31.2%	32
Cray Research	37.2%	50.6%	37
Apple Computer	35.5%	28.8%	40
Telex	32.3%	45.8%	43
Tandem Computers	27.1%	28.7%	49
Amdahl	26.6%	96.3%	52
Altos Computer Systems	24.7%	11.1%	54
Wang Laboratories	19.6%	NM	64
DEC	19.3%	22.2%	68
Unisys	18.9%	33.4%	69
Prime Computer	17.1%	7.6%	77
Tandy	13.5%	1.6%	91
Weighted average	**21.6%**	**20.6%**	

Semiconductors

	5-year sales growth	5-year profit growth	1987 rank
LSI Logic	121.0%	NM	9
Micron Technology	94.4%	NM	13
Western Digital	69.3%	NM	20
VLSI Technology	52.0%	NM	28
Silicon Systems	38.5%	14.3%	35
Burr-Brown	19.8%	16.3%	62
Advanced Micro Devices	19.5%	NM	65
Analog Devices	16.3%	13.6%	79
Intel	16.2%	52.5%	80
Siliconix	15.3%	40.2%	81
Weighted average	**22.4%**	**43.2%**	

Distributors

	5-year sales growth	5-year profit growth	1987 rank
Anthem Electronics	38.5%	27.0%	36
Marshall Industries	19.4%	NM	67
Pioneer-Standard Electronics	17.5%	-4.4%	76
Wyle Laboratories	13.4%	NM	92
Weighted average	**18.9%**	**144.9%**	

[1] Acquired by Unisys Corp. Jan 22, 1988
NA = Not available
NM = Not meaningful, company had a loss in one of the base years

Communications

	5-year sales growth	5-year profit growth	1987 rank
Digital Communications Assoc.	66.5%	107.0%	23
Regency Electronics	49.5%	36.8%	29
Timeplex[1]	35.5%	NA	38
DSC Communications	35.5%	16.7%	39
Micom Systems	27.8%	9.0%	47
Bolt Beranek and Newman	27.6%	NM	48
General DataComm Industries	27.0%	NM	50
Dynatech	23.7%	30.3%	55
Cincinnati Microwave	22.9%	17.6%	56
ADC Telecommunications	21.8%	26.9%	58
Avantek	20.6%	4.3%	60
Motorola	12.1%	12.6%	97
Weighted average	**15.8%**	**15.1%**	

Defense

	5-year sales growth	5-year profit growth	1987 rank
Electrospace Systems	28.2%	18.3%	46
Loral	19.6%	17.2%	63
Logicon	18.9%	14.1%	70
AEL Industries	18.8%	52.8%	71
Varo	13.9%	8.5%	88
E-Systems	11.8%	8.2%	100
Weighted average	**15.6%**	**12.9%**	

Capital equipment

	5-year sales growth	5-year profit growth	1987 rank
LTX	20.7%	NM	59
Teradyne	16.5%	NM	78
Gerber Scientific	14.2%	44.0%	84
Hewlett-Packard	14.1%	11.0%	85
Applied Materials	13.9%	NM	87
Nicolet Instruments	13.3%	3.0%	94
Weighted average	**14.2%**	**10.6%**	

Components (other than semiconductors)

	5-year sales growth	5-year profit growth	1987 rank
Molex	18.5%	15.9%	73
AVX	17.7%	38.8%	75
AMP	13.3%	16.0%	95
Cherry	12.3%	-8.5%	96
International Rectifier	11.9%	NM	99
Weighted average	**14.0%**	**15.7%**	

(Continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
1	Sun Microsystems	474.4%	537.5	36.3	6/87	Mountain View, Calif.
2	Lotus Development	369.2%	395.6	72.0	12/87	Cambridge, Mass.
3	AST Research	249.5%	206.0	13.0	6/87	Irvine, Calif.
4	Iomega	185.2%	89.4	-36.7	12/87	Roy, Utah
5	Mentor Graphics	164.1%	221.8	20.3	12/87	Beaverton, Ore.
6	MiniScribe	135.1%	362.5	31.1	12/87	Longmont, Colo.
7	Symbolics	125.0%	103.8	-25.5	6/87	Cambridge, Mass.
8	Oracle	121.3%	131.3	15.6	3/87	Belmont, Calif.
9	LSI Logic	121.0%	262.1	10.7	12/87	Milpitas, Calif.
10	Wyse Technology	102.9%	260.0	18.1	3/87	San Jose, Calif.
11	Stratus Computer	101.9%	184.2	19.4	12/87	Marlboro, Mass.
12	Apollo Computer	98.2%	553.7	21.7	12/87	Chelmsford, Mass.
13	Micron Technology	94.4%	91.2	-22.9	8/87	Boise, Idaho
14	Seagate Technology	88.3%	958.1	139.7	6/87	Scotts Valley, Calif.
15	Daisy Systems	85.7%	100.9	-16.3	9/87	Mountain View, Calif.
16	Kaypro	80.9%	105.6	-9.6	8/87	Solana Beach, Calif.
17	Ashton-Tate	71.3%	267.3	43.1	1/88	Torrance, Calif.
18	Microsoft	69.8%	345.9	71.9	6/87	Redmond, Wash.
19	Archive	69.7%	88.8	6.1	9/87	Costa Mesa, Calif.
20	Western Digital	69.3%	462.5	42.8	6/87	Irvine, Calif.
21	Mark IV Industries	67.6%	291.5	10.2	2/87	West Amherst, N.Y.
22	QMS	67.4%	119.4	8.7	9/87	Mobile, Ala.
23	Digital Communications	66.5%	181.4	27.0	6/87	Alpharetta, Ga.
24	Emerson Radio	56.0%	810.1	26.6	3/87	North Bergen, N.J.
25	Quantum	54.6%	120.8	8.8	3/87	Milpitas, Calif.
26	Micropolis	54.3%	288.3	27.2	12/87	Chatsworth, Calif.
27	Lee Data	53.0%	114.5	5.4	3/87	Minneapolis, Minn.
28	VLSI Technology	52.0%	172.0	8.1	12/87	San Jose, Calif.
29	Regency Electronics	49.5%	495.3	24.3	6/87	Indianapolis, Ind.
30	Intelligent Systems	46.0%	163.0	NA	12/87	Norcross, Ga.
31	Emulex	44.9%	103.8	3.5	6/87	Costa Mesa, Calif.
32	SCI Systems	43.8%	552.9	16.0	6/87	Huntsville, Ala.
33	Xidex	42.5%	572.8	-44.5	6/87	Mountain View, Calif.
34	Ultimate	42.1%	172.9	13.8	4/87	East Hanover, N.J.
35	Silicon Systems	38.5%	81.8	2.8	9/87	Tustin, Calif.
36	Anthem Electronics	38.5%	196.9	5.0	12/87	San Jose, Calif.
37	Cray Research	37.2%	687.3	147.1	12/87	Minneapolis, Minn.
38	Timeplex	35.5%	147.2	NA	6/87	Woodcliff Lake, N.J.
39	DSC Communications	35.5%	312.4	14.6	12/87	Plano, Texas
40	Apple Computer	35.5%	2,661.1	217.5	9/87	Cupertino, Calif.
41	Priam	34.0%	129.6	-41.3	6/87	San Jose, Calif.
42	Intergraph	32.7%	641.1	69.9	12/87	Huntsville, Ala.
43	Telex	32.3%	840.7	77.9	3/87	Tulsa, Oklahoma
44	Ask Computer Systems	31.6%	98.3	8.0	6/87	Los Altos, Calif.
45	Cullinet Software	28.8%	174.9	-27.6	4/87	Westwood, Mass.
46	Electrospace Systems	28.2%	190.7	10.1	3/87	Richardson, Texas
47	Micom Systems	27.8%	196.7	12.2	3/87	Simi Valley, Calif.
48	Bolt Beranek and Newman	27.6%	233.8	-8.0	6/87	Cambridge, Mass.
49	Tandem Computers	27.1%	1,035.5	105.6	9/87	Cupertino, Calif.
50	General DataComm Industries	27.0%	200.6	0.8	9/87	Middlebury, Conn.

[1] Estimate by INP 2/22
[2] Acquired by Unisys Corp. Jan. 22, 1988
NA = Not available

(continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
51	**Data Card**	26.9%	176.1	1.6	3/87	Minneapolis, Minn.
52	**Amdahl**	26.6%	1,505.2	142.0	12/87	Sunnyvale, Calif.
53	**Cipher Data Products**	25.1%	178.2	4.3	6/87	San Diego, Calif.
54	**Altos Computer Systems**	24.7%	153.9	9.7	6/87	San Jose, Calif.
55	**Dynatech**	23.7%	304.7	23.2	3/87	Burlington, Mass.
56	**Cincinnati Microwave**	22.9%	80.9	12.3	12/87	Cincinnati, Ohio
57	**ISC Systems**	22.1%	168.5	6.5	6/87	Spokane, Wash.
58	**ADC Telecommunications**	21.8%	166.9	15.3	10/87	Bloomington, Ind.
59	**LTX**	20.7%	120.6	-6.7	7/87	Westwood, Mass.
60	**Avantek**	20.6%	213.7	11.6	12/87	Santa Clara, Calif.
61	**Evans & Sutherland**	20.1%	134.4	14.7	12/87	Salt Lake City, Utah
62	**Burr-Brown**	19.8%	140.5	4.3	12/87	Tucson, Ariz.
63	**Loral**	19.6%	690.0	57.5	3/87	New York, N.Y.
64	**Wang Laboratories**	19.6%	2,836.7	-70.7	6/87	Lowell, Mass.
65	**Advanced Micro Devices**	19.5%	997.1	-48.1	12/87	Sunnyvale, Calif.
66	**Diasonics**	19.5%	267.6	15.2	12/87	South San Francisco, Calif.
67	**Marshall Industries**	19.4%	286.6	5.1	5/87	El Monte, Calif.
68	**DEC**	19.3%	9,389.4	1,137.4	6/87	Maynard, Mass.
69	**Unisys**	18.9%	9,712.9	578.0	12/87	Detroit, Mich.
70	**Logicon**	18.9%	204.8	6.1	3/87	Torrance, Calif.
71	**AEL Industries**	18.8%	108.4	3.3	2/87	Landsdale, Pa.
72	**Recognition Equipment**	18.7%	264.7	11.2	10/87	Dallas, Texas
73	**Molex**	18.5%	386.8	43.4	6/87	Lisle, Ill.
74	**Applied Magnetics**	18.0%	211.9	14.2	9/87	Goleta, Calif.
75	**AVX**	17.7%	271.9	15.8	12/87	Great Neck, N.Y.
76	**Pioneer-Standard Electronics**	17.5%	212.2	1.8	3/87	Cleveland, Ohio
77	**Prime Computer**	17.1%	960.9	64.8	12/87	Natick, Mass.
78	**Teradyne**	16.5%	377.7	-21.1	12/87	Boston, Mass.
79	**Analog Devices**	16.3%	370.4	18.7	10/87	Norwood, Mass.
80	**Intel**	16.2%	1,907.1	248.1	12/87	Santa Clara, Calif.
81	**Siliconix**	15.3%	122.5	3.9	12/87	Santa Clara, Calif.
82	**Coherent**	14.6%	159.0	-1.1	9/87	Palo Alto, Calif.
83	**Hadco**	14.6%	124.3	2.6	10/87	Salem, N.H.
84	**Gerber Scientific**	14.2%	223.9	21.1	4/87	South Windsor, Conn.
85	**Hewlett-Packard**	14.1%	8,090.0	644.0	10/87	Palo Alto, Calif.
86	**Measurex**	14.0%	227.4	26.8	11/87	Cupertino, Calif.
87	**Applied Materials**	13.9%	174.4	0.3	10/87	Santa Clara, Calif.
88	**Varo**	13.9%	95.3	3.5	4/87	Garland, Texas
89	**Zenith Electronics**	13.8%	2,362.7	-19.1	12/87	Glenview, Ill.
90	**Printronix**	13.8%	123.7	-4.9	3/87	Irvine, Calif.
91	**Tandy**	13.5%	3,452.2	242.3	6/87	Fort Worth, Texas
92	**Wyle Laboratories**	13.4%	368.0	5.8	1/88	El Segundo, Calif.
93	**Computer Consoles**	13.4%	148.4	9.6	12/87	Waltham, Mass.
94	**Nicolet Instruments**	13.3%	121.6	5.4	3/87	Madison, Wis.
95	**AMP**	13.3%	2,318.0	250.0	12/87	Harrisburg, Pa.
96	**Cherry**	12.3%	160.6	2.7	2/87	Waukegan, Ill.
97	**Motorola**	12.1%	6,700.0	308.0	12/87	Schaumburg, Ill.
98	**Key Tronic**	12.0%	107.6	0.5	6/87	Spokane, Wash.
99	**International Rectifier**	11.9%	151.8	-17.2	6/87	El Segundo, Calif.
100	**E-Systems**	11.8%	1,227.2	60.4	12/87	Dallas, Texas

Source: ELECTRONIC BUSINESS

Can a company spend too much on quality?

A joint poll by ELECTRONIC BUSINESS and Coopers & Lybrand suggests many firms may be penny-wise and quality-foolish

BY IRWIN KRAUSE
AND CHERYL R. SUCHORS

Most electronics companies in the United States are spending too much to make quality products. They are quality-concerned, but not yet quality-wise.

High quality at low cost is an area in which U.S. manufacturers in the automotive, small appliance and semiconductor industries, to name a few, have taken a drubbing from the Japanese in the past decade. As a result, quality has become a foremost issue for U.S. electronics companies.

We found in a recent survey of 144 electronics companies, jointly conducted by ELECTRONIC BUSINESS magazine and Coopers & Lybrand, that in nearly half of the companies, the head of quality control (QC) reports directly to the president or chief executive officer.

Unfortunately, despite this high-level situation, most of the companies surveyed still take an old-line approach to QC. Most companies in the survey have documented test and inspection procedures. Many have also developed a QC organization, have written QC policies and manuals, and currently use sophisticated test and measurement equipment. About 81% also use sampling plans; 75% perform 100% inspection.

These are the standard components of a traditional QC program — one that is chiefly based on a group of QC personnel finding the flaws in everyone else's output. The QC organization acts as the official guardian of quality; no one else is consistently held responsible for it.

Of course, if this were the entire story, we would simply urge companies to review their policies to catch up with the times. We'd advise them to consider the progressive approach to quality — what is being increasingly referred to as "total quality control." This approach implies that everyone who plays a part in design and development, production, sales or service of a product also bears responsibility for the quality of that product. Because everyone is accountable for the quality of his or her own output, statistical methods of quality control are all that's required. These methods emphasize doing things right the first time, rather than relying upon later inspection to sort the bad from the good.

But, our survey results show most electronics companies are well aware of some of the latest techniques in total quality control. Paradoxically, they are implementing them right alongside the traditional techniques they were designed to replace.

We found, for example, that as many as 58% of those surveyed regularly employed statistical quality control methods; and 49% regularly utilized statistical process control techniques. But the redundancy of performing 100% inspection *and* using statistical techniques spells an unnecessarily high cost for quality.

A key tenet of the sound total quality control strategy is the notion of eliminating steps in the production process which add no value. We contend that all the companies which reported using 100% inspection methods — three-quarters of the participants — also have an immediate opportunity for large cost savings by eliminating this procedure. If a good vendor assurance program is instituted, and each person controls the quality of his or her output, inspecting each and every product after each critical step of production is wildly redundant. Building quality into a product adds value; checking to see if it's there adds only cost.

In our view, U.S. electronics firms,

Techniques companies use to assure quality

Annual revenue of companies ($ millions)

	Under $20	$20 to $50	$50 to $250	$250 to $500	$500 to $1 billion	Over $1 billion	All companies
Sampling plans	75%	94%	100%	88%	100%	100%	81%
100% inspection	72%	89%	90%	75%	80%	78%	75%
Statistical QA	51%	72%	70%	75%	80%	72%	58%
Statistical process control	40%	56%	50%	50%	60%	83%	49%

Survey is based on a questionnaire mailed to 1,750 managers of U.S. electronics firms selected at random from ELECTRONIC BUSINESS magazine's circulation. In all, executives from 144 separate firms responded for a response rate of 8.2%.

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

while concerned enough about quality to implement new techniques, don't believe in the techniques enough to forego their traditional ways. From their responses, we conclude that most companies have already adopted some tactics of a cost effective total quality control strategy, but not the underlying philosophy which makes it cost effective. And they are paying the price for it, both in terms of artificially high costs to produce their products, and in market share lost to competitors who have implemented the techniques of total quality control.

How much does QC cost?

In our experience, most companies simply don't know how much their efforts to control quality cost. We believe the same is true for many of the survey participants, and it's a serious problem. If a company doesn't know what its true cost of quality is, it cannot have a cost effective total quality control strategy. Unknown costs can't be questioned, controlled or reduced. Profits are lower than they should be, as a result.

Several of the questions in our survey asking participants about the cost of quality in their organizations went largely unanswered. Of course, respondents could have been concerned about divulging confidential information. However, this seems unlikely as a primary motivation because close to two-thirds of the respondents estimated the cost of quality as a percentage of company revenue in 1986 and 1987. An additional 12% acknowledged they just didn't know those costs.

Even more telling is the fact that companies typically didn't include the full gamut of attendant costs in their estimates of quality cost. Engineering design changes, vendor certification, software "bugs," salaries of quality managers and supervisors, and depreciation of capital equipment for QC — while not obvious total quality control costs — nonetheless contribute to the cost of producing quality goods. Only a small percentage of the survey participants included these areas when determining their annual cost of QC.

United States versus Japan

Adding up the true cost of their current level of quality would shock many companies, especially if they both perform redundant quality operations and ignore critical areas such as vendor and software quality. A substantial percentage of the companies surveyed, 38%, had no vendor QC system. They risked the quality of their own products, or at least increased their cost of goods sold, by trusting that their vendors had functioning quality programs. A growing portion of the value-added of electronics products also derives from associated software. Only 43% utilized a software QC program. While some of the survey participants might not develop any product-associated software, none of the industry sectors rated highly in this component of total quality control.

Of those companies that were able to estimate the total cost of QC, most spend under 15% of sales to control quality, but a few spend as much as 15%. In contrast, the average Japanese company boasts a total quality control program that costs only 5% to 10% of sales. Consistently adopting the progressive techniques of total QC — and moving away from the traditional approach — would puncture the inflated quality costs American companies typically experience. Cutting quality costs dramatically can usually be accomplished with no incremental out-of-pocket dollars or added resources.

World class competitiveness requires implementation of a total quality control strategy in which workers have been given the training and the tools to control their processes. Management must provide the resources to establish process capability; non-value-added activities must be eliminated; and the "quality health" of the business must constantly be measured in terms of quality cost. Market share belongs to the leaders in total quality control.

Irwin Krause is the partner-in-charge of Coopers & Lybrand's new Center for Manufacturing Technology and past national director of Computer Integrated Manufacturing at Coopers & Lybrand

Cheryl Suchors is the director of the National High Technology Industries Group at Coopers & Lybrand

Top cost elements of quality assurance

Percentage of companies which include the element in figuring their annual cost of quality assurance

Inspectors	65%
Rework	64%
Scrap	59%
Quality engineers	54%
Quality managers and supervisors	49%
Warranty costs	47%
Vendor certification	37%
Engineering design changes	32%
Depreciation of quality assurance equipment	31%
Process control	31%

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

Components of quality assurance programs

Components of QA program	Annual revenue of companies ($ millions) Under $20	$20 to $99	Over $1 billion	All companies
Documented inspection/ test procedures	82%	94%	100%	88%
QA organization	61%	100%	94%	77%
Written management - policy for QA	63%	88%	78%	76%
Accurate, up-to-date measurement and test equipment	56%	94%	89%	74%
QA/QC manual	57%	82%	72%	70%
Easily accessible quality records	57%	71%	72%	65%
Vendor QA program	48%	65%	78%	62%
Philosophy that each inspects own work	57%	77%	83%	62%
QC procedure for product software	24%	41%	67%	43%

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

U.S. firms in Japan: Weak dollar is no panacea

Even with the weak dollar, many U.S. companies stumbled in Japan last year. IBM Japan's earning plunged 30%. Fuji Xerox's fell 21%

BY PAULA DOE

The 10 leading U.S.-owned electronics companies in Japan reported sales of over $14 billion last year, up 23% from 1986. Nearly half of the increase came simply from more favorable exchange rates, but sales in yen were still up 14% for the year. That's a little better than the Japanese industrial electronics market overall, which grew by 10% for the fiscal year ended March 1987, according to the Electronic Industries Association of Japan.

Some major U.S. companies sharpened their strategies and took advantage of the cheap dollar to make impressive gains. Fuji Xerox Company Ltd. increased its yen-based sales by 31%. Yamatake-Honeywell Company Ltd. similarly achieved 30% growth. And Nihon Digital Equipment Corp. made some real money. The company's sales were up a modest 6%, but its pretax earnings increased by more than five times, climbing to $98 million, or a very fat 24% of sales.

But overall, U.S. electronics companies have yet to reap big gains from the 40% slide in the dollar against the yen over the past two years. Total yen sales for the top 10 declined 7% in 1986, and climbed back in 1987 to only 6% over their 1985 level. The 40% change in relative costs isn't bringing many companies fat profits either — half of the companies saw earnings decline in 1987, paced by a 30% drop at IBM Japan Ltd.

ELECTRONIC BUSINESS tracks the sales and earnings of companies in Japan that are at least 25% owned by U.S. electronics firms. We get figures directly from those companies that will release them. For the many companies that will not, we get data from the Japanese tax authorities, which is published in a number of Japanese language sources. The market research firm Dataquest in San Jose, supplies figures for U.S. semiconductor companies' sales in Japan. We don't try to track U.S. firms that sell through agents in Japan.

Changes at IBM Japan

IBM Japan recovered from a dismal 1986, when it saw its first-ever decline in revenue, to increase sales by 15% in 1987, becoming the first U.S. company to reach the ¥1 trillion sales (roughly $7 billion) mark. However, IBM paid for its sales gains with a 30% drop in pretax earnings. And it embarked on a new and uncharacteristic strategy of working closely with a host of Japanese companies as it tried to orchestrate a recovery and reach its ambitious goal of doubling sales by 1990.

IBM Japan started selling other companies' equipment in its systems, and allowing others to sell its equip-

Marty Braun

ment. It agreed to supply Ricoh Company Ltd. with IBM personal computers to sell under the Ricoh brand name. (Ricoh had long sold NEC Corp. PCs.) IBM Japan also invested in a number of regional software houses and systems engineering firms, and is reportedly sending key technical people to work with them. Company officials are escorting executives from Japanese computer companies on tours of IBM's research laboratories and factories in the United States, leading to speculation of cooperation with Mitsubishi Electric Corp., Oki Electric Industry Co. and Toshiba Corp.

IBM is not the only U.S. computer company active in Japan. Nihon DEC, the Japanese subsidiary of Digital Equipment Corp., is gaining share in Japan's medium-sized computer market. The company sold $169 million worth of midsized hardware in the fiscal year ended March 1987, for a 6.5% share of the market and a position as the No. 6 supplier, according to International Data Corp. (IDC) in Framingham, Mass. While sales of most suppliers were flat, and while IBM Japan and Fujitsu Ltd. saw 10% to 11% declines, DEC gained 8%.

"NEC and Nihon DEC are the big winners in the Japanese medium-scale market," notes Donald Bellomy, senior consultant at IDC. "DEC moved successfully into the financial community for the first time, with sales to Sumitomo Bank and Nomura Securities." In fact, Nihon DEC is so enthusiastic about the Japanese financial market that it reportedly has three salesmen in New York charged with selling to the U.S. offices of Japanese institutions.

The Japanese subsidiary of DEC aims to increase dramatically its revenue from the business sector, from 20% of total sales today to 50% in the future. To churn out the necessary business applications software, Nihon DEC gave development machines to some 150 to 200 software companies, and plans to double its software staff of 500 by 1990.

The rising star of the Japanese small computer market is NCR Japan. Even though its overall sales decreased last year, the company saw a 25% growth in its sales of small machines. The 25% increase by far outpaced the market's growth of 6%. NCR sales of $62 million gave the company about 1.5% of the $4.2 billion market, according to IDC. Nihon DEC owns about 1.9% of the market, IBM Japan about 7%. □

Top U.S. electronics companies in Japan

By sales	1987 sales ($ millions)	Percentage change (in yen)	Fiscal year ended
IBM Japan	$7,014	15%	12/87
Fuji Xerox	2,968	31%	10/87
Nippon Univac	1,100 [1]	6%	12/87
Yamatake-Honeywell	795	30%	9/87
Sumitomo 3M	783	22%	10/87
NCR Japan	593	-16%	11/87
Burroughs Japan	500 [1]	9%	12/87
Yokogawa-Hewlett-Packard	500	-22%	10/87
Nihon DEC	404	6%	6/87
Texas Instruments	396 [2]	0%	12/87

All 1987 yen figures were converted to dollars at the 1987 average rate of ¥144 = $1
[1] Company estimate
[2] Estimate from Dataquest Inc.

Source: ELECTRONIC BUSINESS

By income	1987 taxable income[1] ($ millions)	Percentage change (in yen)	Taxable year ended
IBM Japan	$653	-30%	3/87
Fuji Xerox	151	-21%	3/87
NCR Japan	108	-1%	3/87
Nihon DEC	98	437%	3/87
IBM Japan Sales[2]	74	72%	3/87
Sumitomo 3M	51	85%	3/87
AMP (Japan)	49	11%	3/87
Yokogawa-Hewlett-Packard	49	-13%	3/87
Nippon Univac	46	30%	3/87
Yamatake-Honeywell	40	-9%	3/87

[1] Some figures may have been reduced by losses carried forward from previous years. An exchange rate of ¥187 = $1 was used.
[2] IBM Japan Sales is considered a separate subsidiary for reporting purposes by the Japanese government. IBM Japan Sales is IBM Japan's export arm.

Source: Taxable income reported to the Japanese government, compiled by Tokuan Data Bank and published in Toyo Keizai's annual ranking of Japan's 20,000 most profitable companies. No figures are available for companies that sold through an agent and are not independently incorporated in Japan

Powerful PCs push supermicros up and out

Now faced with stiffer competition from 386-based PCs, Altos, Arix and Plexus are networking into new markets

BY JAN MURPHY

Small companies offering Unix multiuser machines to the business community are getting some real competition as they work to hold onto their share of the supermicrocomputer market.

When they first appeared, the supermicros, affectionately called "hot boxes," were powerful enough to support several users at a fraction of the cost of a traditional mainframe or supermini. But now that personal computers sporting Intel Corp.'s 32-bit 80386 chip and Motorola Inc.'s 32-bit 68020 processors have reached the market, and AT&T's Unix operating system is gaining popularity, makers of Unix supermicros are facing a throng of competitors. Chief among those original hot-box vendors are Altos Computer Systems, Arix Corp. and Plexus Computers Inc., all of San Jose.

Though decidedly crowded, the supermicro Unix multiuser market is still healthy enough to support a range of vendors.

Kate Comiskey, program manager for Unix research at International Data Corp., a Framingham, Mass., market research firm, says that the 1987 worldwide shipments of Unix multiuser systems generated about $5.7 billion in sales. The total market of Unix single and multiuser systems is expected to show a 32% compound annual growth rate over the five-year period between 1986 and 1991.

Still, survival of smaller companies is an issue. Tim Bajarin, executive vice president of San Jose market research firm Creative Strategies, framed the issue as a question: "With PCs becoming more powerful and superminis becoming cheaper, what do companies like Altos need to do to survive?"

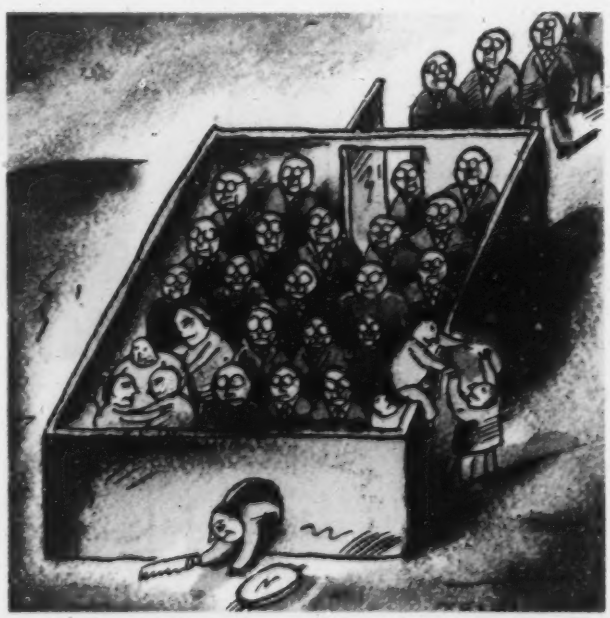
Psst! "Consolidate"

Some analysts whisper an encouraging word to these small companies, and the word is "consolidate." For Altos, consolidating means actively looking for third-party contracts with original equipment manufacturers and value-added resellers.

Altos' newest systems are part of its 386 series, which uses the Intel 80386 processor. The 1000 model costs from $7,500 to $15,000 and supports four to 16 users, while the 2000 model costs from $20,000 to $30,000 and supports 10 to 64 users. Both systems run a version of AT&T's Unix V.3 operating system, though MS/DOS is also supported. Altos' current marketing strategy centers on its local area network product, AdLANtes, which combines either the X.25 or Ethernet protocols with its models 1000 or 2000.

"We have the ability today to go into any shop with a few PCs in it and tie it to an IBM mainframe via an Altos box," says Sam Spadafora, senior vice president for national sales and marketing, speaking about AdLANtes.

According to Spadafora, the Altos system is a hub in the network for communications among the PCs and the IBM mainframe. The Altos system also acts as a shared storage unit and traffic cop for the PCs across the LAN. He adds that any kind of IBM-compatible PC or graphic workstation can be added to an AdLANtes network, which he hopes will open the door for a variety of third-party contracts. Altos sells exclusively to OEMs and VARs.



Robert Neubecker

Altos' net sales are steadily increasing, with $153.9 million for 1987, compared with $134.1 million for 1986. And Spadafora says the company is exploring specialized vertical markets in which to cultivate even more third-party contracts. In March, Altos signed an agreement with Unisyn Corp., a manufacturing VAR in Boulder, Colo., which opens a new niche for the company. Altos sells 30% of its systems to the medical community, with one of its most prominent resellers being Ortho Management in Atlanta. Altos also sells 20% of its systems to wholesale distributors,

20% to manufacturers, 8% to construction and the rest to financial markets.

IDC's Comiskey says that while Altos is strong, "they will be faced with more competition." But, she adds that "they're also the vendor that everyone is trying to catch."

Like Altos, Arix — formerly known as Arete Systems Corp. —sells exclusively through third-party channels. "And we believe we can continue to grow by selling through OEM and VAR contracts," says Mike Lambert, vice president for marketing and sales.

Arix's largest and most publicized OEM is Unisys Corp., which accounts for over 70% of Arix's revenue. Deane Tierney, Unisys program marketing manager for the Arix products, sells the Arix systems as part of the Unisys 5000 series. He says that the U 5000/95 model starts at $68,000 and supports from 16 to 128 users. The U 5000/85 system starts at $39,900 and supports from 16 to 80 users. Both systems run Unisys System V operating system, release 3.0, which is like the AT&T System V.3.

One market for the models, Tierney says, consists of companies that need a standalone departmental system for distributed data processing, with the system perhaps being tied into other systems via an Ethernet LAN. The other market is the small business that would use either model as a type of mainframe.

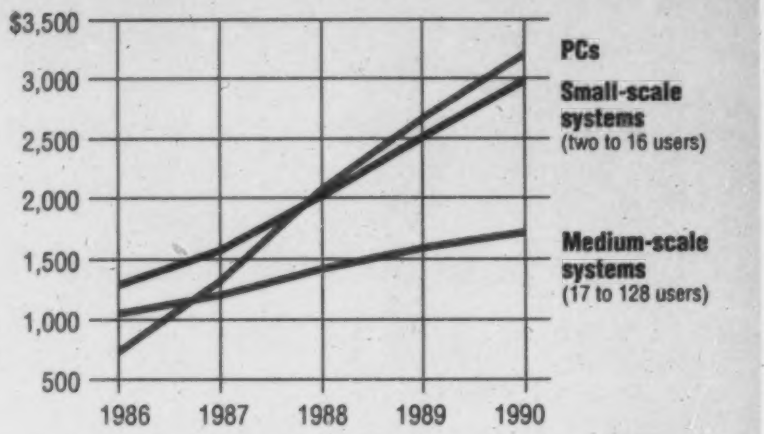
Tierney adds: "Typically, it's a unique solution for the small company, put together with a database software such as Oracle or Informix."

With the February 1988 announcement of the Unisys/Arix contract extension and enhancement, worth up to $150 million over the next three years, Arix's health will continue to be closely linked with the fortunes of Unisys. But Arix's Lambert says the company is aggressively pursuing additional contracts with four or five major system integrators and that Arix is establishing four regional distribution centers. With revenue for fiscal 1987 at $42 million, compared with $30 million for fiscal 1986, Arix is continuing its streak of profitable quarters, says Lambert.

Greg Marus, an analyst with Dataquest Inc., a market research firm in San Jose, says that "[Arix] is smart enough to broaden their market base" and to expand its OEM and VAR contracts.

Unix-based multiuser computer systems market

Sales by U.S. vendors in the U.S. market ($ millions)



	1986	1987	1988	1989	1990
PCs	$746	$1,298	$2,064	$2,683	$3,220
Small-scale	1,285	1,542	2,005	2,506	2,982
Medium-scale	1,054	1,221	1,429	1,600	1,728

Source: International Data Corp.

Diversify

At Plexus, Tom Frederick, vice president for marketing, says that the company is not hearing the word "consolidate." Plexus is hearing the word "diversify" — very loudly.

"As the Unix market matured," says Frederick, "we found that our customers wanted more than just a box. Customers wanted us to sit down and help them solve a problem."

Plexus listened to its customers. The company found that 80% of its customers used the Plexus systems to solve database problems. New technologies for gathering data, such as scanners, imaging devices and new storage devices such as optical disks, were just some of the new peripherals customers wanted to integrate into a single system. The result is that Plexus created its XDP (extended data-processing) series to help manipulate and store "compound data:" text, images and numbers. Frederick says that XDP is "the natural evolution of our database product."

So Plexus changed its market niche by opening up a new one. In 1987, says Frederick, 60% of Plexus' sales went through third-party channels and integrators; 40% went directly to end users. Where once Plexus was selling systems at a base price of about $25,000, it now sells its XDP system at a base price of about $75,000, although the average price is in the hundreds of thousands. Sales for the nine months between the XDP's debut in March 1987 and December 1987 reached $15 million.

Plexus also sells direct to end users, unlike Altos and Arix, and it has been expanding its salesforce. In effect, Plexus is becoming a supermicro company that is competing with systems such as Wang Laboratories Inc.'s Integrated Image System and Eastman Kodak Co.'s Image Management System.

So what does the future hold?

In dollars and cents, analysts say that the Unix multiuser market is strong and is expected to grow. Altos and Arix have looked at their competition in the marketplace and have decided to strengthen their offerings through a variety of OEM and VAR contracts. Plexus, on the other hand, has decided to branch out in a new direction. But all three companies are ready for the next perilous phase of the maturing Unix multiuser market: its adolescence. □

Optical scanners: Patience has finally paid off

It took over a decade, but improved technology and marketing are finally pushing scanner sales skyward

BY BRIAN DEAGON

After 15 years of development and marketing, the manufacturers of optical scanners are beginning to envision healthy market growth.

Although optical scanner technology — sometimes just called scanners — emerged from labs in 1970, only 11,000 products were shipped in 1986 in the United States and Europe. But what a difference a year makes. In 1987, scanner shipments more than tripled to roughly 39,000 units, reports San Jose-based market research firm Dataquest Inc. Combined revenue topped $110 million. Dataquest forecasts that in 1991, about 379,000 scanners will be shipped, totaling roughly $645 million in revenue. Unit shipments will grow 63% annually between 1987 and 1991.

Scanner manufacturers couldn't be more pleased. Many of them have nurtured this slow-growth industry with new products for more than 10 years. Scanners were touted as the elixir for information overload in paper-intensive industries, but users found more problems than solutions.

"This industry is two years behind where experts thought we'd be," relates Jim McNaul, vice president for strategic planning for Datacopy Corp., in Mountain View, Calif. One reason is that manufacturers failed to convince users that optical scanners were beneficial to business. Morever, the scanner industry was late in defining its niche markets.

In practice, many scanners got poor reviews from users. "Some days they work perfectly. Other times they just won't read a page," says Denise Provost, a communications manager for the Boston-based law firm of Mintz, Levin, Cohen, Ferris, Glovsky & Popeo Inc., which has used scanners for seven years.

Manufacturers have been challenged to design scanners that read a multitude of font styles. Early versions could read only three font styles. U.S. and Japanese firms struggling with scanner problems have found solutions mostly through software development.

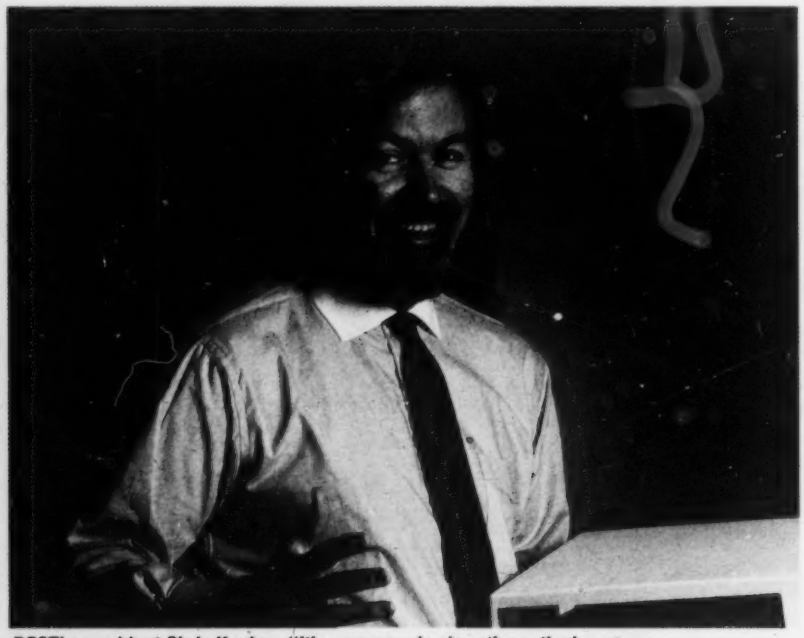
For instance, several manufacturers sell software by OCR Systems Inc. of Bensalem, Pa., as an option. The software enables a scanner to read upward of 2,000 different variations of type sizes and more than 10 foreign languages.

"There will always be an error rate," says Gregory Boleslavsky, OCR Systems vice president. "But we've passed the threshold where it's finally cost productive to use scanner technology. The vital difference is that four years ago only 5% of documents could be read. Now it's 80%."

Scanners that read data only use optical character recognition (OCR) devices. OCR technology recognizes scanned data by matching the images with what's stored in computer memory.

Another variation, called image scanners, reads photographs, line art or graphics and then translates them into computer language. Image scanners were introduced in the early 1980s and have played a key role in the emergence of a low-end market.

Image scanners can be purchased for about $2,000. OCR techniques can be added for an additional $500 in software. Combined image/OCR



DEST's president Chris Kenber: "It's enormously clear the optical scanner market is beginning to take off"

Tim Davis

capabilities previously cost about $10,000. When they were first introduced they cost upward of $50,000. More enhanced image/OCR scanners can read hundreds of font variations and provide more than 250 shades of gray scale coloring of images at 400 dots-per-inch resolution.

"A lot had to come into place for this industry to grow," says Steve Nickel, director of The Technology Group in Evanston, Ill. "Scanners needed to be reasonably priced, distribution channels and user awareness had to emerge, and an infrastructure of applications needed to be identified," he adds.

Key developments needed to accelerate market demand include the introduction of optical scanners with multiple capabilities. Scanners now read data as well as images. Other promising developments include the proliferation of new add-in boards that make scanners work just like a facsimile machine. Computer-based communication systems will be one of the fastest growing segments of the image communication market, predicts CAP International Inc., a market research firm located in Marshfield, Mass.

One early scanner leader, DEST Corp., based in Milpitas, Calif., entered the rapidly growing facsimile market in July 1987 through the acquisition of Gulfstream Micro Systems Inc.

DEST appears well poised for market growth. The company is now showing its second-generation high-end image scanner to vendors and has dropped the price on its first-generation product from $10,000 to $6,000. This event comes six months after the introduction of its second-generation low-end scanner, which works with both IBM and Apple Computer Inc. systems.

"It's enormously clear the optical scanner market is beginning to take off," grins Chris Kenber, DEST president and chief executive.

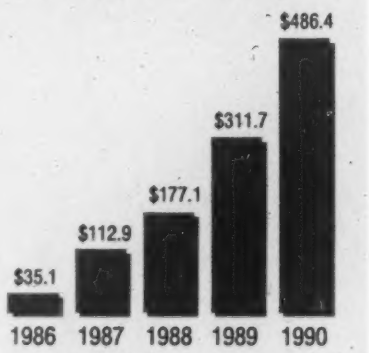
DEST had to pay hearty dues along the way, however. In the early 1970s, DEST was one of the first companies to introduce an OCR scanner which was embraced by legal and financial firms with large word-processing departments. However, it could only read two kinds of fonts and the machine was often confused by nonstandard page design.

Another impetus to growth has been the boom in desktop publishing. As scanner features rise and prices fall, they become a complementary peripheral in that market. "Scanners are a natural tool for selling desktop publishing systems," says Graham Harding, engineering vice president for scanner manufacturer Micro Technology Products, in Gardena, Calif. "Desktop publishing has come of age and people always want to add more to it," asserts Harding.

One dilemma is that the OCR-only scanner market is not expanding fast enough, says Michael Perkons, general manager for CompuScan Inc., a scanner manufacturer in Fairfield, N.J. Although retail pricing has dropped tenfold, service and distribution costs have remained the same, he says. In addition, dedicated OCR devices costing about $10,000 can now be replaced with OCR/image scanners for under $5,000 for general office use.

Desktop scanners

North American market ($ millions)



Source: Dataquest Inc.

Revenue and shipments of dedicated OCR scanners peaked in 1986 at $44.8 million and 3,400 units, CAP reports. OCR shipments will decline roughly 10% a year through 1991.

Enter the Big Three

Many observers say an industry shakeout in the optical scanner market is developing. Eyes are poised on IBM, Apple, and Xerox Corp. These three have yet to take bold steps that could change the shape or direction of the market, although they are in a position to do so, observers note.

Hewlett-Packard Co. is another company being watched. HP has had noteworthy success with its low-end ScanJet for the IBM and compatible marketplace, but it scrapped plans to introduce an Apple compatible scanner last year. Industry observers expect Hewlett-Packard to cause greater ripples in the next two years.

Apple will make its mark soon by introducing its first image scanner in the second quarter of this year, several analysts say. Dataquest has revised its market figures upward to account for Apple's anticipated presence. It predicts Apple will ship 18,000 scanners in the second half of 1988.

IBM has had only limited success in the scanner market, but is predicted to be tough competition if it antes up more funds for development and marketing. IBM's two scanner models are outdated, analysts note.

Xerox's anticipated entry into the scanner market is likely to be leveraged on the success of Cambridge, Massachusetts-based Kurzweil Computer Products Inc. Kurzweil, a Xerox company, is a leading supplier of high-end optical scanners. It is the first major company to integrate artificial intelligence technology into scanner products.

Kurzweil's so-called intelligent character recognition (ICR) technology is envied by the competition. ICR technology can electronically repair characters that may have faded or were improperly joined by poor reproduction. The product, with 4-megabyte RAM, can scan five languages and costs $11,950.

Eyes are also on three key suppliers of scanner engines. They are: Canon U.S.A. Inc; Ricoh Corp., based in Japan; and Taiwan-based Microtek Lab Inc. All three not only supply the engines on an OEM basis, but also sell their own brand-name scanners through regular distribution channels, including retail.

For example, Kurzweil buys its engines from Ricoh, Hewlett-Packard buys from Canon, and Texas Instruments Inc. from Microtek. DEST is the only major manufacturer that builds its own engines. IBM makes its scanners in Japan.

"It's becoming a very competitive market from a vendor's perspective," says Ed Wong, Dataquest research analyst. "If vendors base their product on one of three engines, the only difference is software and pricing." □

Flexible printed wiring reaches for consumer markets

Japan leads in flex for consumer uses; the U.S., in military. Both are growing, but it's hard to bend high prices

BY ALBERTO SOCOLOVSKY

Open the back of Polaroid's new Spectra instant camera. Easier yet, peer inside the Onyx model, which has a translucent back. A small, rigid printed circuit will be very visible. Look harder; around it, you will see flexible printed circuits at work, one flexing when the back opens, another folded into recesses and around corners to reach the controls in the camera's frame.

This camera is a good application for the two types of interconnection jobs that flexible printed wiring is called upon to perform, says Craig B. Self, Polaroid Corp.'s technical purchasing agent. There's the dynamic application, in which "flex" connects to a moving element, as in the camera's cover; and the static application, where they are "folded, contorted and crammed," to fit into tight spaces.

More stressful dynamic applications can be found in computer peripherals such as hard disk drives and printers, where flexible wiring connects to the rapidly moving slide arm or printhead, respectively. In addition to consumer and computer products, other nonmilitary applications such as automobiles, cellular phones and portable medical electronics equipment promise to fuel the growth of printed wiring in the next decade.

Polaroid's Spectra instant camera features both dynamic and static applications of flexible printed wiring

This should be good news for the merchant makers of flex because the military market, where flex was born more than 30 years ago to wire snugly packed space vehicles, is not expected to grow much in the next five years. Yet, military applications of flexible printed wiring, many of them captive, last year accounted for more than half of the $400 million U.S. market, according to the research firm William Jacobi & Associates of Bennington, Vt. By contrast, Japan has a market of the same size, but with no military content.

"In both countries, fabricators have felt protected from the outside world," says president William Jacobi. "In the U.S., because defense markets won't allow foreign intrusion. And, in Japan, because the user base is there; in square feet, they've 85% of the world's production of flex." Japanese designers of electronic equipment are well trained in the applications of flex, whereas in the United States, says Jacobi, "we think in mil specs; many fabricators are not used to responding quickly to nonmilitary users."

Already, the independent makers of flex, which Jacobi ranks the two largest as Sheldahl Inc. of Northfield, Minn., and Rogers Corp. of Rogers, Conn., derive most of their revenue from nondefense users, and have automated roll-to-roll, continuous print-and-etch processes to reduce fabrication costs. The third-ranked company, Parlex Corp. of Methuen, Mass., is largely military. Sheldahl and Parlex have been expanding, through acquisition, into each other's turf. In fourth place may be GM

Hughes Connecting Devices, in Irvine, Calif., which is mostly military but trying to wean itself from dependence on its big defense parent. Hughes' commercial cousin, GM Packard Electronics, all captive to GM, may be the largest fabricator of flexible circuits in the United States, primarily polyester-based flex for dashboards.

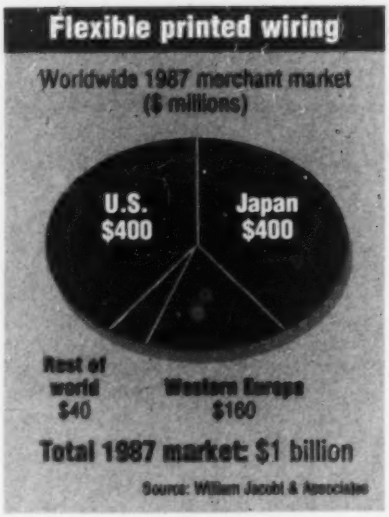
The three leaders expect the flex market to grow by 20% this year, because the potential applications for flex are multiplying. "It's no longer a niche market," explains Harvey Miller of Kirk-Miller Associates, a consultancy in Palo Alto, Calif., that specializes in the printed circuits field. Miller offers two reasons, one marketing and one technological, for flex's fair future: "Think of all the new electronic equipment that is becoming smaller, like cellular radios," he says, "and how well flex lends itself to surface mount components."

Price isn't so flexible

Yet, for flex to expand its markets, price also has to become more pliable. All military flexible circuits are built with several layers of copper-clad polyimide, a heat resistant, dimensionally stable but more costly plastic film. Polyimide is the preferred substrate; not just for high-temperature duty, but in general, because it does not degrade in assembly while soldering the circuit's components. Du Pont Electronics is the major supplier of the film, under its Kapton trade name, which it sells to laminators such as Fortin Industries Inc. of Sylmar, Calif., and Sheldahl.

Two years ago, Du Pont Electronics introduced its own laminate for flexible printed wiring, a copper-clad Kapton called Pyralux, and is already the United States' largest vendor of copper-clad polyimide. According to the Institute for Interconnecting and Packaging Electronic Circuits (IPC), polyimide owns more than 60% of the flexible laminates market in the United States, followed by polyester, which is less heat resistant but costs about one-third the price of polyimide.

Sheldahl is the polyester flex leader. "With 60% of our [$70 million in 1987 flex] sales, we're the clear leader in commercial circuitry," says Keith Casson, director for technical marketing. Sheldahl makes the flex for Polaroid's Spectra camera,



and is a major supplier to Texas Instruments Inc.'s educational toys and to Ford Motor Co.'s dashboard wiring. Rogers, which counts IBM as a big customer for polyimide flex, has developed a low-cost material for static applications. Called Bend/flex, it can bend once to fit into the package and stay there without further bending.

Polaroid opted for the lower cost film even though its lower temperature rating "makes it more difficult to solder the SM components," says Self. But it also selected rolled annealed copper, a more ductile but more expensive cladding than electrodeposited copper.

Military uses of flexible printed wiring last year accounted for over half the $400 million U.S. market

However, the higher price of flex versus rigid printed wiring is offset by its simpler packaging. "You need fewer cables and connectors," says J. Lee Parker of AT&T's Bell Laboratories, in Richmond, Va., who chairs the IPC's design committee for flex. "This improves reliability and reduces cost."

IBM has evaluated extensively the reliability of SMC assemblies on flex. "It's a good match," says Jeffrey A. Collett, staff engineer at IBM's Application Business Systems division in Rochester, Minn., "because the substrate is compliant. But this property makes assembly harder to automate, because it's difficult to hold the substrate planar."

Not every OEM has that kind of expertise. "I was visiting Tandon's [disk drive assembly plant] in Singapore a few years ago," says Dr. Carmelo J. Santoro, chairman of Silicon Systems Inc., a Tustin, Calif., supplier of ASICs for Winchester disk drives, "and saw the yield loss they were taking in mounting chips on flex." To supply tested flex assemblies to such customers, SSI joined with Rogers in a venture called Smartflex Systems. So far, Smartflex has been more successful with high-end disk drive makers, such as Maxtor Corp., than with Tandon and other low-end vendors, because the assembly represents a smaller portion of the total cost in a high-end drive. "Purchasing people don't value the value we add," laments Santoro. "The real sell is at engineering, manufacturing, and quality management."

Since many Japanese electronics manufacturers are already sold on flex, the eyes of American flex suppliers are on the Stateside operations that Japanese automobile and consumer electronics OEMs are opening. "We've a strategy to penetrate these companies," says Sheldahl's Casson. Some of that strategy is based on Japanese connections; Sheldahl has a reciprocal minority ownership deal with Sumitomo Bakelite, and Rogers has a joint venture, Rogers Inoue Corp.

But Japanese suppliers are not ready to give up their customers; they even may try an end run to capture U.S. accounts by leveraging their experience in SM and in mass production. "Japan's [Nippon] Mektron is the largest supplier of flex in the world," says Du Pont Pyralin marketing manager, Calvin Cruz. "They've a high volume 'roll-to-roll' process." Nippon Mektron, which was a Rogers licensee until 1986 and can use in Japan the Rogers-owned Mektron name, already has been courting the big U.S. OEMs. "But we're not worried about pricing anymore," says Rogers' marketing director Robert D. Wachob. "The world has changed." □

Can MAP make it on the factory floor in 1988?

So far, the factory network's shifting specs have scared off customers. As MAP 3.0 wares debut, 1988 may be different

BY SYLVIA TIERSTEN

MAP — Manufacturing Automation Protocol —is an idea whose time has been coming — and coming — and coming. In mid-1984, General Motors Corp. offered a feasibility demonstration of the factory floor computer networking protocol at the National Computer Conference, which "really whet people's appetites," recalls Michael Kaminski, GM's manager for advanced manufacturing engineering.

In early 1985, GM upped the ante by announcing MAP specs and promising to "keep them in place at the vendors' request for at least two years," according to Kaminski. The protocol, intended to establish a standard means of communications between computers and production cell equipment from many different vendors, appeared at the Autofact '85 show in its 2.1 broadband version, which supports multiple data channels simultaneously.

Roughly six months later, 2.1 products became available. Although GM implemented several 2.1 and 2.2 (carrier band) systems, a number of potential vendors and customers played a waiting game. "It was apparent early on that the 2.X standards were only emerging ones," recalls Julie Pingry, editor of the *CIM Strategies* newsletter in Arlington, Mass.

GM's MAP master, Mike Kaminski: "MAP equipment vendors knew we were continuing to develop [the specs] so they decided to wait"

Junebug Clark

Hailed as the year that MAP would take off, 1986 wasn't — and MAP didn't. "They [the MAP equipment vendors] knew we [GM] were continuing to develop functionality within the 1988 time frame," says Kaminski, "and when they heard that, they decided to wait for it. In a sense, we were the victims of our own enthusiasm."

To date, MAP hardware and software have failed to make a serious impact on the factory floor, leaving Ethernet-based proprietary networks like Digital Equipment Corp.'s DECnet and Hewlett-Packard Co.'s version with the upper hand. Market research firm Venture Development Corp. (VDC) of Natick, Mass., puts Ethernet's share of the 1987 market for industrial LANs at five times that of MAP. Researcher, Dataquest Inc., estimates that in 1987, not more than $29 million worth of broadband MAP products were shipped.

This may be about to change. One recent issue of a market research newsletter was headlined: "MAP vs. Ethernet: The battle is on." Some MAP proponents now see 1988 shaping up as a pivotal year for the technology — and the Enterprise Networking Event (ENE) '88 as a pivotal show. The June 5 through June 9 ENE exhibit in Baltimore will serve, among other things, as a launching pad for new 3.0 MAP products. This latest MAP version promises more functionality than its 2.X predecessors — and a considerably longer shelf life. The reason? From June 1988 through June 1994, 3.0 network specifications will be frozen for upward capability.

"The MAP/TOP (Technical and Office Protocol) Users Group lobbied hard for that freeze," says Robert S. Crowder, president of Ship Star As-

sociates in Newark, Del., a CIM/MAP consulting firm. Apparently, he adds, "GM thought stability was only important to the vendors. I don't think they perceived the extent of the problem — particularly among users in some of the smaller companies." For example, robot makers, faced with a narrow marketplace and fluctuating standards, have been unwilling to invest heavily in high-performance MAP interfaces.

Freezing the specs

According to Julius Dorfman, president of market research firm Cimdata Inc., Wellesley Hills, Mass., the six-year freezing of standards will produce 100% annual growth in the sale of broadband MAP products over the next few years.

Unlike Autofact '85, the Enterprise show is "an exhibition of deliverable product and not just another demonstration project," says industry analyst Bob George of San Jose-based Dataquest Inc. He thinks that this year "will prove that MAP is real." George cautions that fiber-optics networks could cut into projected broadband MAP sales as their price performance rises.

Offering a more guarded assessment is VDC analyst James K. Brown, who recently surveyed large users of factory communications networks. Brown's worst-case scenario is an unsuccessful Enterprise show in which 3.0 products simply fail to work. A second, somewhat less ominous possibility, he says, is "a narrowing of the amount of things they try to do with the network at the show, which would also be a kind of failure."

Until now, he contends, MAP has failed to take the advanced manufacturing market by storm because "a lot of people don't want to bet their factory on a new and unproven technology." And even if Enterprise '88 is a huge success, neither Brown nor anyone else expects proprietary networks to vanish overnight.

"Vendors want to squeeze as much as they can out of those proprietary networks, so it makes sense for them to continue support for those products," says Mark Shaw, senior administrator of the Society of Manufacturing Engineers' (SME) MAP/TOP Users Group in Dearborn, Mich.

The primary focus of the upcoming Enterprise show is on using open systems interconnection (OSI) to custom manufacture products in a multivendor, computer-integrated environment. "This is the first show that I know of with multivendor capability on one network," says the SME's Shaw. "What we've seen before is little islands of proprietary networks." Look for "a very steep curve of MAP and TOP implementations" by mid-1989, with some leveling off in the market in the 1991-1992 time frame, adds GM's Kaminski.

Unlike earlier MAP versions, 3.0 specifications offer some degree of functionality at all seven protocol layers. These are, in ascending order: physical; data link; network; transport; session; presentation; and application.

The freezing of standards is expected to produce 100% annual growth in sales of broadband MAP products over the next few years

The presentation layer, which earlier MAP products did not contain, provides translations between standardized data formats. MAP 2.1 and 2.2 also lacked network management capability and directory services in the seventh, or application layer. The 3.0 version "is not anyone's idea of the optimum network management service," says Charles Chriss, marketing vice president for Retix, a Santa Monica, Calif., supplier of OSI protocols. Nevertheless, he contends, "there is now sufficient functionality for practical networking."

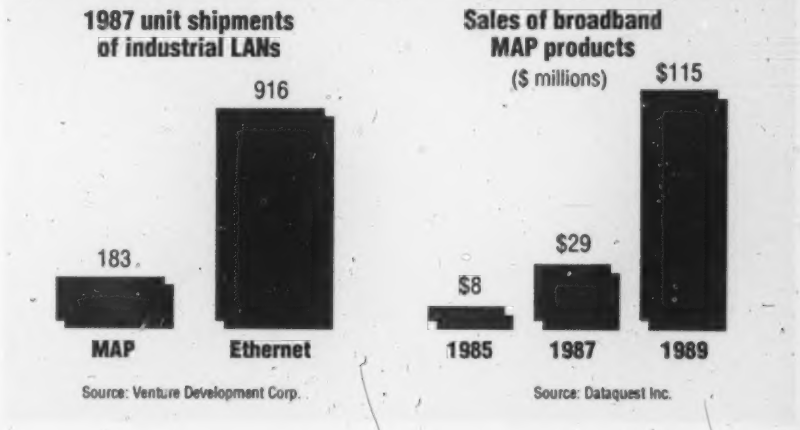
Migration from a 2.1 to 3.0 environment will involve some incompatibilities, particularly at the upper layers, as will migration from proprietary local area networks. "HP, IBM and DEC are all looking at how they can integrate with OSI," says Shaw. Ethernet, for instance, which runs on 802.3 media, would encounter compatibility difficulties mainly at the top MAP layers.

Migration is a critical issue. According to Paul DePond, director for product marketing of systems software for networks vendor Ungermann-Bass Inc., of Santa Clara, Calif., people will not buy MAP 2.1 unless vendors at the ENE exhibit "can show an absolute migration to 3.0 that is not too expensive." As for MAP's ultimate fate in the marketplace, issues of cost and utility still remain: process control and automotive manufacturers value the noncollision aspects of 802.4 token-bus, but other types of manufacturers may find less costly proprietary LANs more than adequate.

The higher price of MAP

Currently, MAP products sell for roughly twice as much as proprietary LANs. The upfront cost for a serial communications board for small networks of GE Fanuc programmable controllers is $1,500, as opposed to

So far, MAP products aren't hot items



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Next August 15, ELECTRONIC BUSINESS will publish its annual directory of Services for the Electronics Industry. If your company can help other electronics and computer companies complete a project on time, save costs, reduce risk, get to market faster and safer, increase efficiency, improve quality, or any other pertinent electronics service, the name of your company or division, and the type of service it provides for our readers, belong in the pages of the ELECTRONIC BUSINESS directory.

Example of services that will be listed:

Design: product design, circuit design, custom ICs, design centers, software development, package and packaging design, thermal design, documentation.

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- Name, address and telephone number of company or division that performs the service. If available, add telex and fax numbers.
- Type of service: Please be specific. (If you enter in more than one category, such as design and manufacturing, please list separately.)
- Name of manager(s) responsible for services for electronics and computer companies. Include direct telephone number, if available.
- Current volume of sales of this type of service to electronics and computer companies.
- Number of employees at this company or division, involved in this type of service.
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- Name of at least one client among electronics and/or computer companies.

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$3,150 for a MAP interface, according to Henrik Schutz, senior product planner for GE Fanuc Automation North America. A standardized network, however, can reduce costs associated with training, installation, maintenance, spare parts inventory, updating, wiring, custom hardware and software. As MAP gains market credibility, prices should come down, say industry participants. Motorola Inc. is already offering a carrier band, single-channel MAP interface for under $1,000.

In its present version, MAP can transmit data at the rate of 10 megabits per second on a broadband and 5Mb on a carrier band. An important, if sometimes overlooked MAP advantage over Ethernet, is MAP's

Some MAP proponents see 1988 shaping up as a pivotal year

ability to run Manufacturing Messaging System, an applications protocol for machine-to-machine communications that works well with robots.

For some factory applications, proprietary LANs outshine MAP in functionality terms. "If you have two robots," says GM's Kaminski, "and you want to move something from one arm to the other — you may want to link them with proprietary protocol." A high-speed camera might talk to a robot via a non-MAP protocol, but you still ought to have MAP capability to link up vision devices to the computers above them," he says.

Some customers maintain that users will ultimately demand MAP — and get it. One that has invested heavily in automation is agricultural machinery maker Deere & Co. Says Gary Blunck, project manager of Deere Technical Services: "The fallacy that we hear from DEC and some of the other vendors is that they are only talking about a closed environment. But large companies like ourselves with diverse equipment find that installing multiple proprietary equipment is just too much of a headache."

Sylvia Tiersten is a San Diego-based business writer

The element of overseas

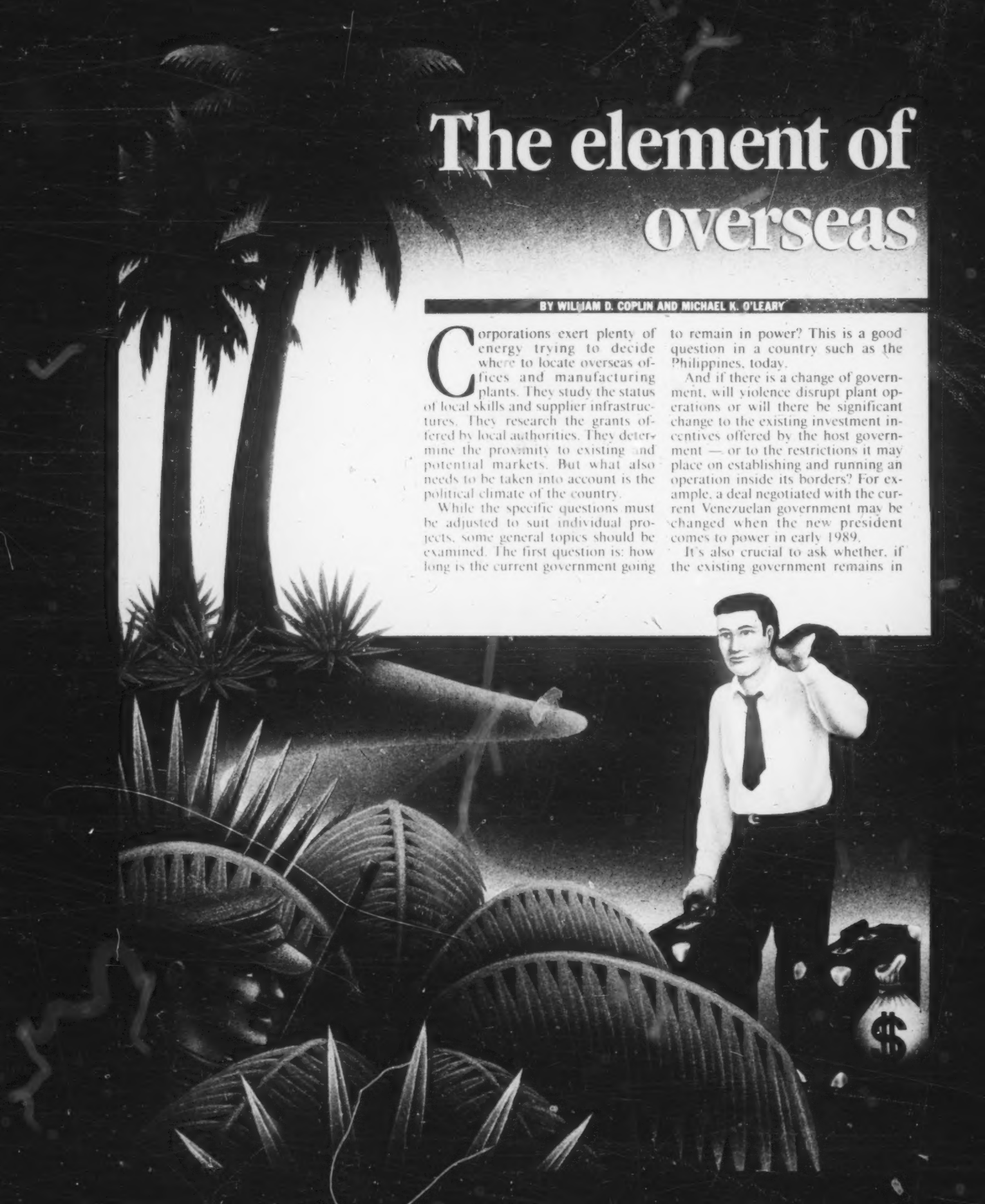
BY WILLIAM D. COPLIN AND MICHAEL K. O'LEARY

Corporations exert plenty of energy trying to decide where to locate overseas offices and manufacturing plants. They study the status of local skills and supplier infrastructures. They research the grants offered by local authorities. They determine the proximity to existing and potential markets. But what also needs to be taken into account is the political climate of the country.

While the specific questions must be adjusted to suit individual projects, some general topics should be examined. The first question is: how long is the current government going to remain in power? This is a good question in a country such as the Philippines, today.

And if there is a change of government, will violence disrupt plant operations or will there be significant change to the existing investment incentives offered by the host government — or to the restrictions it may place on establishing and running an operation inside its borders? For example, a deal negotiated with the current Venezuelan government may be changed when the new president comes to power in early 1989.

It's also crucial to ask whether, if the existing government remains in



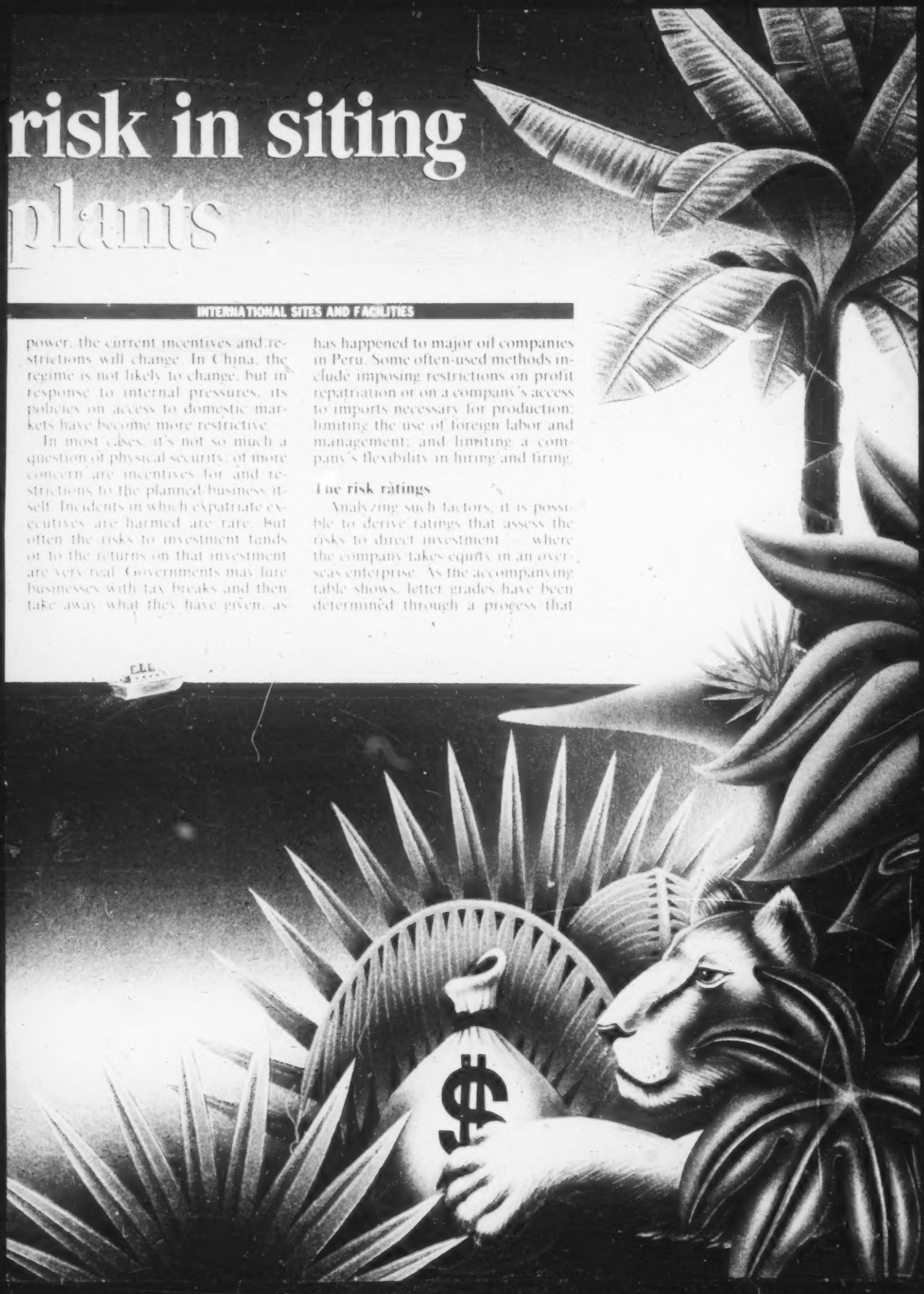
risk in siting plants

power, the current incentives and restrictions will change. In China, the regime is not likely to change, but in response to internal pressures, its policies on access to domestic markets have become more restrictive.

In most cases, it's not so much a question of physical security; of more concern are incentives for and restrictions to the planned business itself. Incidents in which expatriate executives are harmed are rare, but often the risks to investment funds or to the returns on that investment are very real. Governments may lure businesses with tax breaks and then take away what they have given, as has happened to major oil companies in Peru. Some often-used methods include imposing restrictions on profit repatriation or on a company's access to imports necessary for production; limiting the use of foreign labor and management; and limiting a company's flexibility in hiring and firing.

The risk ratings

Analyzing such factors, it is possible to derive ratings that assess the risks to direct investment — where the company takes equity in an overseas enterprise. As the accompanying table shows, letter grades have been determined through a process that



projects the risks to foreign investment in wholly owned subsidiaries, joint ventures, and other forms of direct ownership of assets. Making these assessments requires the combination of information about the level of risk, forecasts of the three most likely regimes, and an evaluation of risks to business. For short-term forecasts, Frost & Sullivan evaluates the following risk factors:

- turmoil;
- equity restrictions;
- restrictions on local operations, including policies related to labor, management, and procurement;
- taxation discrimination;
- repatriation restrictions;
- exchange controls;
- labor costs.

In making five-year forecasts, the short-term forecast is calculated along with:

- the long-range outlook for turmoil;
- the relative strength of forces supporting and opposing restrictions on international investment;
- the forecasts of change under three most likely 5-year regime scenarios;
- the country's ranking and prospects on domestic and international economic indicators.

To answer questions about the present and future political climate, electronics executives need to draw on individuals and groups with substantial expertise on the underlying factors that determine the country's environment for international business. They need to be careful not to rely on sources that have a vested interest in the status quo, for instance, banks, the U.S. government, or the host government; or those with vested interest in change, such as political risk insurance companies, newspapers, and opposition politicians.

In essence, it is important to remember the underlying political climate and the potential for significant changes. The key is to know who's in power, who is likely to be in power, and whether policies — therefore, incentives and restrictions — are likely to change.

Coplin and O'Leary are directors of Frost & Sullivan's Political Risk Services unit

Where it's risky — and where it's not

This is only a partial listing of the nations assessed by Frost & Sullivan. ELECTRONIC BUSINESS has, because of space constraints, chosen only those countries it believes have the strongest presence in the electronics industry.

Under each country is the date of Frost & Sullivan's last update or report, followed by the 18-month (top row) and 5-year (bottom row) political forecast: with, left to right: risk ratings for turmoil (low to very high); and ratings (A+ the least to D- the most) for the risks to transfer of funds; to direct investment funds and exports to the country. Parentheses indicate a recently updated forecast.

	Turmoil	Funds transfer	Investment	Export
Argentina	Moderate	C+	B-	C
(11/87)	Moderate	C	C-	D+
Australia	Low	A	A	A-
(8/87)	Low	B+	A	B
Austria	Low	A+	A	A+
(6/87)	Low	A+	A+	A+
Belgium	Low	B+	A	B+ (A-)
(6/87)	Low	B+ (A-)	A-	B+
Brazil	High	D	C	D
(12/87)	High	D+	C-	D
Canada	Low	A-	A-	A
(11/87)	Low	A-	B+	B-
China	Low	B-	B	C+
(12/87)	Moderate	B-	C+	C-
Egypt	Moderate	C-	B	C-
(7/87)	Moderate	C	C-	D+
France	Moderate	A-	A-	A-
(9/87)	Moderate	B+	B+	B+
Hong Kong	Low	A+	A	A+
(1/88)	Low	A+	A (A+)	A+
India	Moderate	B	B	B
(11/87)	Moderate	B-	A-	B+
Indonesia	Low	B-	B+	B-
(9/87)	Low	B	B	B-
Ireland	Low	A-	A	A
(8/87)	Low	A	A-	A-
Israel	Moderate	C+ (B-)	A-	B-
(1/88)	Moderate	C+ (B-)	B+ (A-)	B
Italy	Low	B+	A+	A
(12/87)	Low	B	A	B+
Japan	Low	A+	A	A+
(11/87)	Low	A+	A-	A

	Turmoil	Funds transfer	Investment	Export
Malaysia	Moderate	B+	B+	B+
(12/87)	High	C+	C	C
Mexico	Moderate	C+	B	C+
(12/87)	High	C	D+	D+
Netherlands	Low	A+	A+	A+
(1/88)	Low	A (A+)	A- (A+)	A- (A+)
Philippines	Very high	B-	B	C+
(1/88)	Very high	D+	D+	D+
Portugal	Low	B+	A-	A
(10/87)	Low	B+	A-	B+
Puerto Rico	Low	A+	A+	A+
(1/88)	Low	A (A+)	A+ (A)	A
Singapore	Low	A	A	A+
(8/87)	Low	A	A+	A+
South Africa	High	B	C+	C+
(9/87)	Very high	C+	C-	C-
South Korea	Moderate	A- (B+)	B	A (A-)
(1/88)	Moderate	B (B-)	C+ (C+)	B- (C+)
Spain	Moderate	A-	A	A
(11/87)	Moderate	B+	B+	B+
Sweden	Low	A	A+	A+
(6/87)	Low	A	A	A
Taiwan	Moderate	A-	B+	A-
(1/88)	Low	A	A	A-
Thailand	Moderate	B	B+	B-
(4/87)	Low	B+	B	B-
United Kingdom	Low	A+	A	A+
(10/87)	Low	A+	A-	A-
Venezuela	Low	D+	B-	C
(11/87)	Low	C+	C+	D+
West Germany	Low	A+	A+	A+
(1/88)	Low	A+	A+	A+

Strategies for international manufacturing

An analysis of U.S. firms in Europe suggests alternative methods of boosting foreign sales

Traditionally, when companies talked about international manufacturing, it was described in terms of production in low labor cost countries. Now, however, increasing global competition and changing product cost structures have broadened the objectives and changed the strategy of international manufacturing in the electronics industry. Becoming increasingly important is the role international manufacturing plays in leveraging foreign sales.

There are basically four strategies of international manufacturing which companies can follow: home country manufacturing; coordinated global manufacturing; regional manufacturing; or a combination of the coordinated global and regional strategies. Other strategies, such as tax avoidance or currency management, are usually secondary to one of the primary strategies. The appropriate international manufacturing strategy depends on a company's business strategy. As a result of this strategy, the degree of regionalization in international manufacturing can have a significant impact on success of foreign sales.

Comparing strategies

The table shows the European manufacturing presence for selected electronic equipment and computer manufacturers. When the percentage of European sales is plotted against the degree of European manufacturing for these companies, a strong relationship can be seen. The degree of European manufacturing is based on the number, size and focus of plants in Europe at the beginning of 1986. A few companies such as Apollo Computer Inc. and Compaq Computer Corp. have been increasing their European manufacturing since.

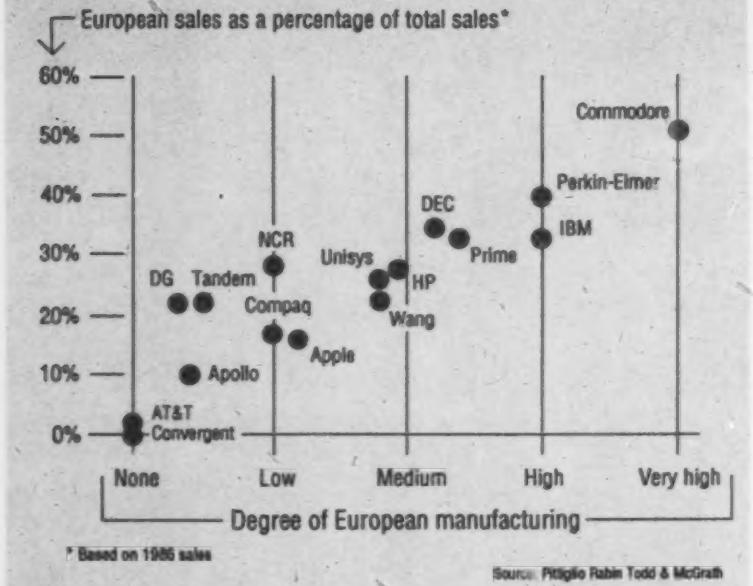
In general, this shows that foreign companies can achieve up to 20% of sales in the European market with little or no local manufacturing. Beyond this point, however, increased manufacturing presence is required in order to achieve higher European revenue. Digital Equipment Corp., Hewlett-Packard Co., IBM, Perkin-Elmer Corp. and Prime Computer Inc. are particularly successful examples. Most of these companies have multiple plants throughout Europe. Prime has a single very large plant in Ireland. Commodore Business Machines Inc. is interesting because it not only has extensive manufacturing in Europe, particularly West Germany, but is even considered by many to be a German company.

This chart shows four quadrants defined by the degree of manufacturing and foreign sales. The quadrant at the upper left, high European sales/low degree of foreign manufacturing, is not a viable strategy. Until recently, it has been a viable strategy for some Japanese manufacturers due to the advantages of manufacturing in Japan and the openness of the European markets, as well as in the U.S. consumer and semiconductor markets. But the world has changed. These markets are less open, and the manufacturing advantage is less significant. As a result, companies like Hitachi Ltd., Matsushita Electric Industrial Co., NEC Corp. and Sony Corp. are strategically moving to the quadrant at the upper right by expanding manufacturing into their markets.

In a recent study on international manufacturing strategies of the large electronics companies, Pittiglio Rabin Todd & McGrath found that companies following a home country or a coordinated global strategy averaged 22% foreign sales, while those with a regional or combined strategy averaged 36%. This difference can really be viewed as a potential increase in total sales of 14% or as an increase in foreign sales of 60%.

The ability to leverage sales through manufacturing is not only confined to a specific country. Regional accords between alliances such as the European Economic Community (EEC); the Andean Pact (a trade agreement between several South

Correlation between sales and manufacturing



* Based on 1986 sales

Source: Pittiglio Rabin Todd & McGrath

European manufacturing presence

1986 sales Company	Total sales ($ millions)	European sales ($ millions)	Percent sales in Europe	Percent assets in Europe	European manufacturing facilities
Apollo	$392	$40	10%	23%	Scotland[1]
Apple	1,902	312	16%	9%	Ireland
AT&T	34,090	NA	NA	NA	England
Commodore	889	455	51%	43%	West Germany
Compaq	625	109	17%	14%	Scotland[1]
Convergent	305	0	0%	0%	None
Data General	1,267	283	22%	15%	None
DEC	9,389	3,252	35%	23%	Scotland, Netherlands, England, Ireland, West Germany, France
Hewlett-Packard	7,102	2,009	28%	19%	England, Scotland, West Germany, France, Spain
IBM	51,250	17,078	33%	32%	France, West Germany, Scotland, Italy, Sweden
NCR	4,882	1,359	28%	21%	Scotland and others
Perkin-Elmer	1,334	534	40%	33%	West Germany, England, Ireland, Liechtenstein
Prime	860	280	33%	29%	Ireland
Tandem	624	136	22%	17%	West Germany
Unisys	7,432	1,949	26%	17%	West Germany, Belgium, France, Scotland
Wang	2,643	602	23%	17%	Ireland, Scotland

[1] Plant under construction during 1986 NA = Not available

Source: Pittiglio Rabin Todd & McGrath

American countries); and the Lome Convention (agreements between European countries and their former colonies); allow companies to sell their products competitively to a broader market by establishing a regional manufacturing presence. This strategy is different from leveraging sales in a single country because it requires finding a common denominator in dealing with mixed cultures and markets.

Applicability

However, the sales leverage to be achieved by regional manufacturing varies by industry segment as well as by the strategy for an individual company. In addition, there are a few other alternatives to manufacturing which can achieve some amount of leverage.

The communications market is strongly regulated by the government in most countries. The controversy over market "allocation" involving France and Germany concerning the ITT/Compagnie Générale d'Electricité joint venture illustrates this control. British Telecom has traditionally purchased most of its telecommunications equipment from companies manufacturing in Britain, although this is beginning to change.

In the computer market, there is a great deal of evidence suggesting that local presence is more important than technology or cost advantage. For example, IBM has the largest market share in each of the major European markets. The second position is held by the indigenous manufacturer; ICL Ltd. in Britain, Siemens AG in West Germany, Groupe Bull in France and Ing. C. Olivetti & Co. in Italy. IBM has extensive manufacturing in each of these countries and is viewed as a world citizen. The other companies do not perform nearly as well outside their home country.

Except for the protectionism factors, consumer electronics are not as susceptible to leverage from manufacturing. Semiconductor and components are viewed in many cases as worldwide commodities and no one really knows where they are "manufactured." There are exceptions, where customer requirements and customer preference are important.

There are also alternatives to foreign manufacturing, such as offset buying, joint ventures and aggressive marketing, which can improve foreign sales. However, the alternatives do not show successful and long-lasting results.

Implications

Clearly then, international manufacturing does leverage foreign sales. The benefit of this is significant. A company with $500 million in sales, for example, could realize an additional 15%, or $75 million, in revenue and $20 million to $30 million increased profit contribution. The impact varies by industry segment and by company, but it does demonstrate that international manufacturing must be an element of a company's business strategy.

While manufacturing in a country doesn't automatically mean increased sales, expecting significant success without an international manufacturing strategy isn't realistic.

MICHAEL E. MCGRATH

Michael E. McGrath is a director of Pittiglio Rabin Todd & McGrath in Weston, Mass.

International manufacturing strategies

Home country manufacturing — Basically, this is a centralized manufacturing strategy with 90% or more of the manufacturing operations conducted in the company's country of origin.

- Companies use this strategy because they believe that their country has the best manufacturing capabilities, or because they sell primarily into their home market.

Coordinated global manufacturing —This is the classic strategy for taking advantage of low labor cost areas for the manufacture of components and subassemblies.

- This strategy is used by companies focusing on product cost.

Regional manufacturing — Manufacturing operations are deployed into major markets.

- This strategy includes both the manufacture of the same products in each market region or the manufacturing of components and subassemblies in each market region.
- This strategy is typical of a company which uses manufacturing to leverage foreign sales.

Combined regional and coordinated global manufacturing — This involves some component or subassembly manufacturing in low cost regions with final assembly in regions where markets are located.

- It is the most sophisticated strategy with the most complex execution and potentially the highest payoff. □

DRAMs sound the alarm for distributors

If prices stabilize, the recovery may be coming to an end. Why do people double order?

A billion dollars separates the sales of Mayer Electronics Co., a regional distributor in Billerica, Mass., from top-ranked Avnet's Electronics Marketing Group. Mayer's sales are under $10 million, while Avnet chairman Tony Hamilton expects that sales by EMG will best the billion-dollar mark in 1988. More important than the sales gap is their view of suppliers' prices of commodity chips. Hamilton thinks prices of dynamic random-access memories are stabilizing now, whereas Mayer's president Jack Derby calls for late summer.

Price stabilization, says Hamilton, marks the fourth phase of economic recovery for distribution. Phase I is signaled by increasing bookings. Increasing shipments are Phase II; suppliers' deliveries stretch out in Phase III; suppliers' prices stabilize in Phase IV; and distributors' profits increase in Phase V. By those criteria, the distributors that NEDA samples to construct its indices for bookings and shipments may be in Phase I or II because shipments are very strong, while the book-to-bill ratio continues to grow from month to month. Two important members of the NEDA sample, Anthem Electronics, a $200 million distributor that specializes in semiconductors; and Marshall Industries, which is twice the size of Anthem; have increased sales by almost 50% in recent quarters.

Leadtimes haven't stabilized either; double ordering, the dreaded side effect of stretching leadtimes, has been plaguing distributors since the beginning of this year. Hamilton claims to ship 70% of the orders "in 90 days or less. But we see some double ordering for 256K DRAMs and for [Intel] '386 microprocessors," he says. So does Mayer: "We get two calls per week from buyers — not from brokers — who want up to 100,000 256K DRAMs," says Derby.

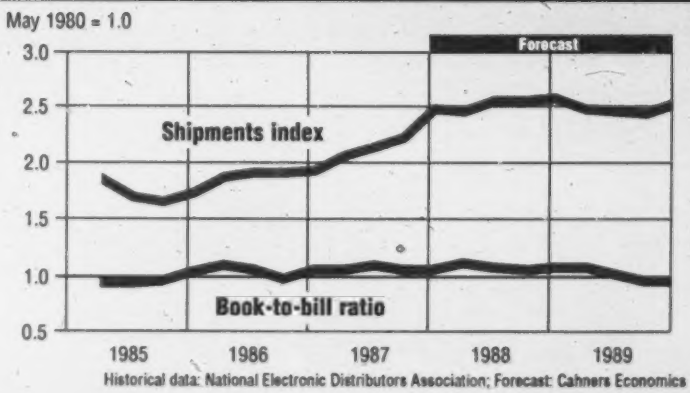
If there is double ordering, how could prices be stabilizing? DRAMs are fetching more than $10 in the spot market. "We could sell [DRAMs] to a black marketeer for twice what we sell to our customers," says Avnet's president Leon Machiz, who heads Time Electronics, a major distributor of Hitachi DRAMs. "But we're not in a price business, we're in a service business."

"No good distributor takes advantage of its customers; buyers have long memories," says Derby. "I have customers who signed up for less than $3; they supported us in the past, and buy other components [besides DRAMs]. With them, if my costs go up, I just try to maintain my margin percentage. I don't want to sell just DRAMs to new customers; we want to make sure that we'll see them all the time after parts become available." Derby, who counts Samsung Electronics as a major line, thinks that 256K DRAMs will become available in the late summer. The reason is that "we've seen more 1 megabit DRAMs lately, at $29 to $34.50." Samsung's ability to deliver the larger chips makes Derby suspect that the purported shortage of Japanese DRAMs is artificial. "I don't believe such great engineering houses have difficulty making them," he scoffs.

Cahners senior economist Elizabeth Baatz forecasts that NEDA's shipments index will rise 15% this year, and that bookings will do even better. That sounds more like Phase I. Even Hamilton, who carries no Japanese lines at Hamilton/Avnet, drools at the market opportunity: "It'd be nice to have a line of Japanese DRAMs, with their huge capacity," he says, wistfully.

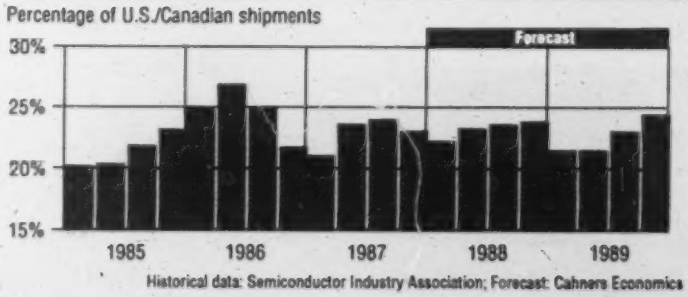
ALBERTO SOCOLOVSKY

Distribution business index



Historical data: National Electronic Distributors Association; Forecast: Cahners Economics

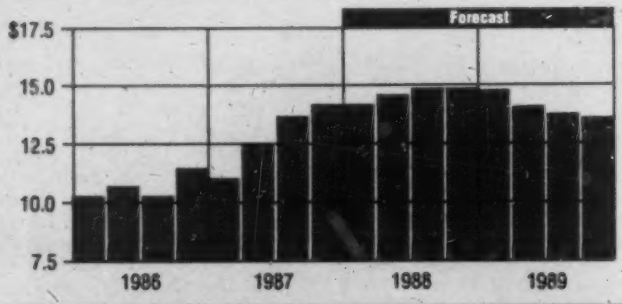
Distributor's share of total semiconductor shipments



Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

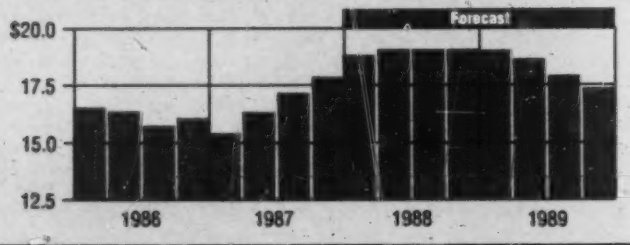
Electronic components — new orders

End-of-quarter totals, seasonally adjusted ($ billions)



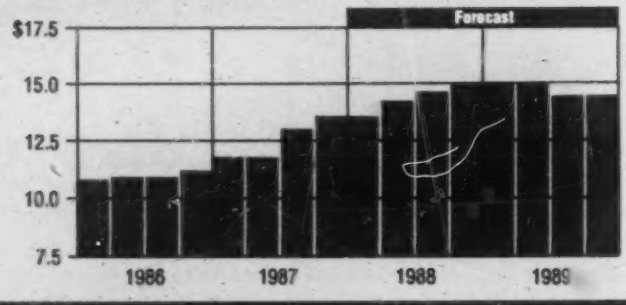
Electronic components — unfilled orders

End-of-quarter totals, seasonally adjusted ($ billions)



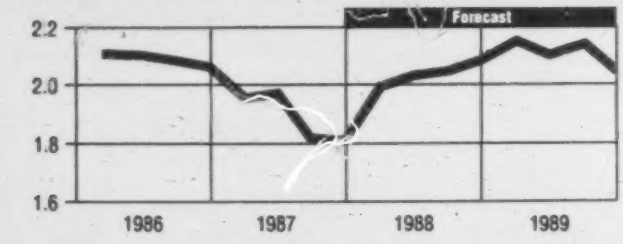
Electronic components — shipments

Quarterly totals, seasonally adjusted ($ billions)



Electronic components — inventory-to-shipment ratio

Quarterly averages, seasonally adjusted



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electronic components future looks rosy

Shipments and bookings of electronic components grew over 4% in the fourth quarter of 1987 from the prior quarter, continuing the upward trend of the current recovery. In a retrospective look at 1987's component statistics, two other vital trends reveal good news for the future.

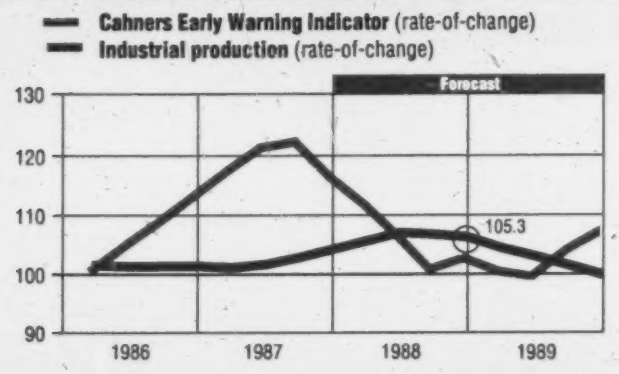
First, bookings remained level with outpaced billings for each of the last nine months of last year (and again in January 1988). This was the best book-to-bill performance since 1984 and bodes well for rising backlogs in 1988. A healthy level of backlogs means U.S. factory production will have a satisfactory buffer for any shipment missteps during the year. Backlogs stood at $17.8 billion in December 1987, the highest level since March 1985, when backlogs hit $18.5 billion.

Second, and more importantly, inventories have remained amazingly low. While inventories have been growing, they have not been surging ahead of shipments. Last year, inventories grew just 3.2% while shipments picked up 14.1%. This inventory control has kept the inventory-to-shipments ratio at its lowest levels ever. This is extraordinary behavior given the fact that the electronic components industry recovery is approaching its two-year anniversary.

In 1985, the inventory-to-shipments ratio for U.S. components makers hit the 2.3 mark. This signaled a serious inventory imbalance. The problem was severe not only at the component factory level, but even more so at the end-user level. As of January 1988, the inventory-to-shipments ratio remained at the 1.8 mark and Cahners Economics does not expect the level to rise above 2.1 over the next year.

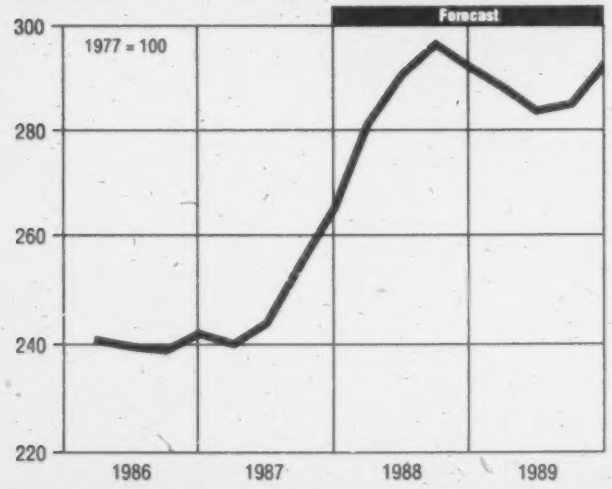
With inventory management now finally taking a front seat in business planning, the electronic components industry will see only a mild downturn ahead in 1989. Cahners Economics predicts orders for components will rise 14.1% in 1988, slowing from the 20.5% growth rate of 1987. Then, in 1989, Cahners expects only a 3.9% drop in orders, far less severe than the 17% free-fall of 1985. In fact, a 3.9% drop in orders may not even result in a decline at all in shipments next year.

Economic indicators



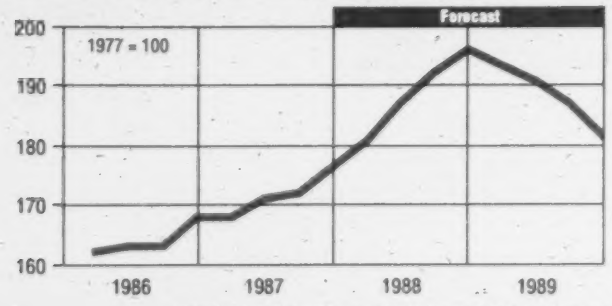
Electronic components — industrial production

Industrial production index, seasonally adjusted quarterly averages



Equipment, instruments and parts — industrial production

Industrial production index, seasonally adjusted quarterly averages



Historical data: Federal Reserve Board; Forecast: Cahners Economics

U.S. production growth remains steady

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according to the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

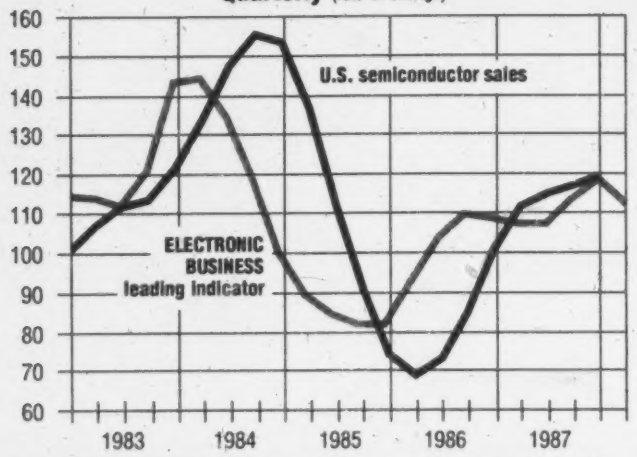
More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Recovery for instrument and component markets

Both the instruments and the components markets continued to shine in the final quarter of 1987 and are expected to have shown similar growth in early 1988. Industrial output of equipment, instruments and parts rose 3.0% in the fourth quarter and is expected to rise another 2.1% in the first quarter of 1988. As for electronic components, the figures for these two quarters stood at 4.1% and 5.9%. The component recovery has been led by a surge in demand for semiconductors. While semiconductor sales in the United States and Canada grew over 20% in 1987, all electronic components output at U.S. factories rose a more modest 5%. In 1988, electronic components output is likely to increase 15.6%. Instruments output is expected to rise 9.8%, after a 4.7% upturn in 1987. With both industries, growing export sales will be a major factor in any optimistic production projections.

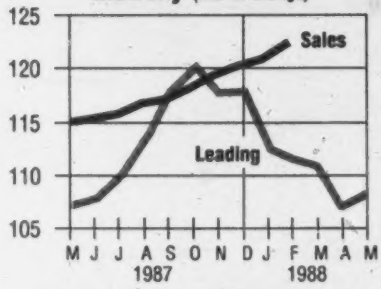
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158 or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator fell to 112.8 in January from 118.0 in December. The majority of the January-December decline in the indicator was due to a drop in semiconductor stock prices. Estimates for the next two months show the indicator dropping slightly to 111.8 in February and 111.1 in March. The turning point peak in this indicator occurred in October 1987, so semiconductor sales growth is expected to begin dropping off this spring.

Source: Cahners Economics

Electronic industry indicators this month

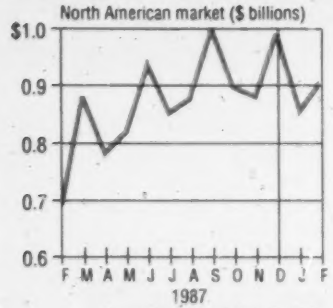
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Jan.)	112.8	118.0	107.8	111.8
U.S. semiconductor bookings ($ millions, 3-month average, Feb.)	$1,080	$1,014	$794	$951
Weekly hours of semiconductor production workers (monthly average, Jan.)	40.3	41.3	40.8	40.6
Electronic components leadtime index (1977 = 100, March)	106.8	105.5	72.7	100.7
Standard & Poor's semiconductor price index (1970 =10, monthly average, Feb.)	52.94	53.18	60.94	65.5
Change in electronic components inventories ($ millions, SA, Jan.)	+$51	+$48	-$30	+$46
Contract and orders for plant and equipment ($ billions, SA, Feb.)	$37.7	$38.5	$32.1	$34.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

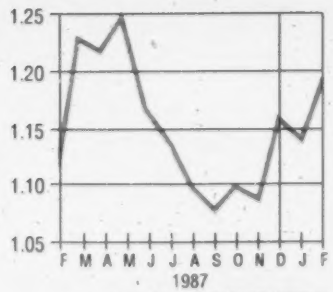
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

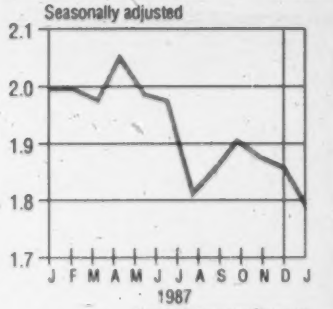
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted



Source: U.S. Commerce Department

SIX DOLLARS

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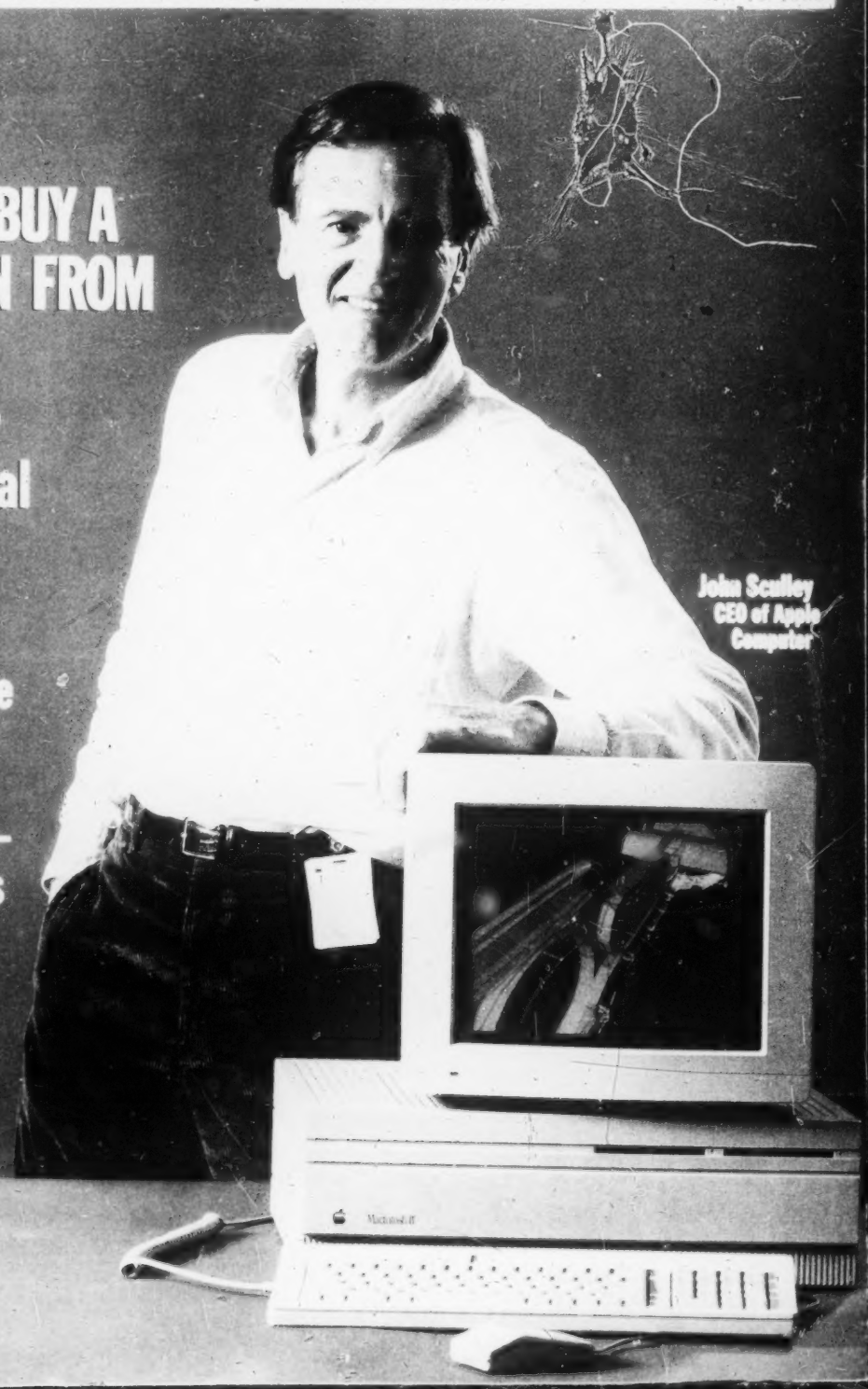
MAY 15, 1988



WOULD YOU BUY A WORKSTATION FROM THIS MAN?

Apple's bid for engineer appeal
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America's mixed messages on trade laws PAGE 14

Top IC production-equipment makers
PAGE 100

John Sculley
CEO of Apple Computer

Electronic Business

AGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 10 MAY 15, 1988

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Apple CEO John Sculley has his eye on the engineering workstation market—which he figures will be worth $1 billion to his company in the 1990s. Sculley expects to trade on the fanatical devotion of Apple Macintosh users and launch the under-$10,000 workstation market. But the Mac II still lacks much in the way of engineering software.

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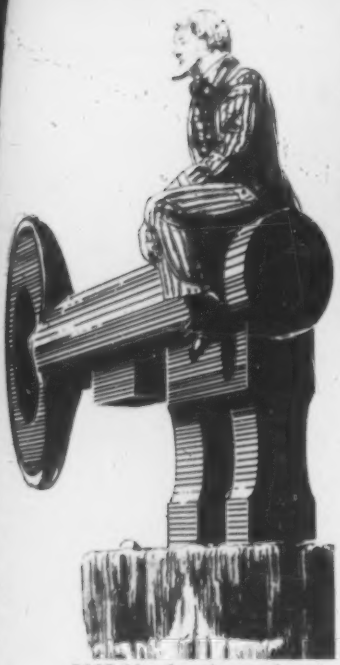
Cover photo: Liane Enkelis



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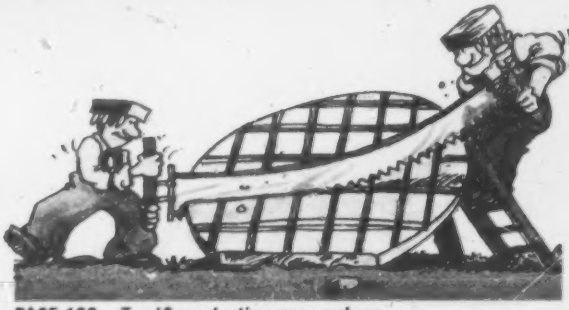

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A peek into the future

It is practically a truism: as computer hardware gets cheaper, faster and more cost effective, the market takes on a kind of commodity character. First, there's a flood of vendors; then a shakeout; finally, only those with deep pockets and manufacturing capability survive.

From the point of the customer, machines become almost interchangeable; software becomes the distinguishing factor; vendors scramble to seize existing distribution channels; and price becomes the overriding feature in the marketplace.

Well, we haven't quite reached that stage yet in workstations . . . but we're awfully close. When a company like Apple — which spent more money last year on public relations and advertising than it did on R&D — unveils an under-$10,000 workstation, we can see the handwriting on the wall. One day, workstations will be as user friendly and prevalent as personal computers.

Don't be misled. We are *not* saying we have seen the future of workstations and it is Apple. But we *are* saying that we have seen the future of Apple and it is workstations.

I strongly urge you to check out our cover story by senior editor Dave Card on where CEO John Sculley is taking Apple in the years ahead. The implications of the Apple story are of consequence to the entire industry. If Sculley — and competitors like Sun Microsystems — can turn a workstation into a commodity item, can supercomputers be far behind?

Adventures in venture

Also in this issue is our once-a-year ranking of the top venture capitalists in the electronics community. To our knowledge, this is the only such list of its kind. We're not particularly interested in providing data on venture capitalists that sink their money into biotechnology or other forms of investment. Our mission is to provide you, our readers, with information about venture capitalists who are oriented toward investment in electronics.

David Card

We believe this list, which was compiled by assistant editor Mary Donovan, will be especially useful to start-ups, as well as to the management of small- and medium-sized companies seeking mezzanine financing. And accompanying our list is, we believe, an insightful article by associate editor Bruce Rayner on the perils of going public. Good reading.

AL FURST
Editor

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VBPA ABP

Would you buy a workstation from this man?

Apple CEO John Sculley wants you to view his souped-up Macintosh II as a low-end workstation too. It looks like one, but it lacks third-party software

BY DAVID CARD

Step right up! *Pree-senting:* the under-$10,000 workstation! Now all engineers can be automated! New markets opened! Affordable artificial intelligence! As an added bonus — or is it a catch? — the machine comes from Apple Computer Inc.

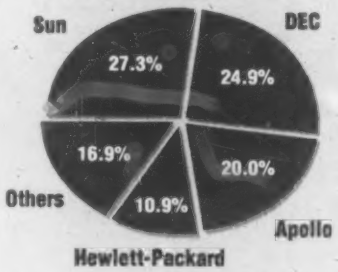
Whether Apple's entree into engineering workstations is bane or boon depends on the degree of your Apple-addiction. Apple hopes to carry the fanatical customer loyalty for its Macintosh personal computer into the workstation market via the souped-up Mac II and a new Technical Markets organization. Time, software and distribution will tell.

"We are in the process now of launching what we think may end up being the single highest growth area for Apple Computer over the next five years — what we call Technical Markets," says Apple chairman, president and chief executive, John Sculley. "[We] helped shape a market with desktop publishing, we think that we can help shape a market with the under $10,000 workstation for engineering," Sculley told ELECTRONIC BUSINESS in a recent interview at his firm's headquarters in Cupertino, Calif. The former Pepsi-Cola Co. president is counting on $1 billion worth of technical business for Apple in the early 1990s.

Introduced in March of 1987, 30 days before IBM first showed its Personal System/2 family, the Mac II sold to the tune of 75,000 units last year. That includes 10,000 units sold into technical applications, according to International Data Corp., a Framingham, Mass., market research firm. IDC analyst Vicki Brown expects Apple to sell 150,000 units this year, 40,000 of which will be used as technical workstations. Brown says the Mac II impact on the workstation market "is going to be huge." She adds that even though Apple "may never get over 10% of the units in technical workstations, that's a lot."

U.S. workstation market

Share of worldwide sales by U.S. vendors



Total 1987 market: $2.76 billion

Source: International Data Corp.

This is the party Apple wants to crash

In part, Sculley is hoping Apple will be able to trade on the increasing popularity of the Mac among a wide range of personal computer users. "What engineers have to have, perhaps even more than raw compute power, is that they have to be able to do personal productivity-type functions as well," Sculley observes. "We bring with us the wealth of all that software base that we have on the Macintosh."

In fact, to a large extent, Apple is a brand name among engineers. Peter Hamilton, general manager of the marketing division for Hewlett-Packard Co.'s Technical Computer group, says that HP, in gathering competitive data, estimates that a third of the PCs installed in the country's engineering departments already come from Apple. "A number of our own engineering/scientific customers have made sizable investments" in Apple computers, he adds.

Chasing the Sun

IDC says U.S. suppliers sold $2.8 billion worth of workstations worldwide last year, with leader Sun Microsystems Inc. accounting for $754 million of the total. Yet Apple shipped more Mac IIs than Sun's entire six-year installed base. No. 2 on IDC's list? Digital Equipment Corp., which just so happens to have a joint-development agreement with Apple. The two agree they will be "friendly competitors," but the friendship may be strained vying for desk space in the engineering departments of the

Larry Ewing

world. [See related story.]

As usual, distinctions are blurring between computer classes, but IDC defines technical workstations by their "multitasking" operating systems, which allow multiple application programs to run simultaneously. These machines are also predominantly sold direct as well as through value-added resellers or original equipment manufacturers.

However, Apple still sells its multitasking machines, including a Unix version, primarily through dealers. To date, it has qualified some 900 of its 2,000 regular dealers to sell the Mac II. Apple also has a direct salesforce that calls on about 75 big clients. But using dealers to sell workstations is a lot more difficult than using them to penetrate the home and office market — because workstations require a lot of support. Summit Strategies, a Boston consultancy, estimates that fewer than 100 of its dealers are capable of supporting workstations.

Lofty goals

However, Michael Homer, who heads up Technical Markets for Apple, is counting on informal partnerships with Apple-compatible hardware and software vendors to give added weight to Apple's engineering presence. At Apple's suggestion, for example, National Instruments — an Apple board maker — uses Apple's name to get into three of Sculley's biggest accounts: Boeing Co., E.I. du Pont de Nemours and Co. and Lockheed Corp. In time, Homer believes, the presence of third-party engineering software to run on the Mac II will help catapult Apple into the No. 1 or No. 2 spot in the under-$10,000 class of the following workstation markets: artificial intelligence; computer-aided design; manufacturing; scientific research; and software engineering.

Michael Homer, Apple's head of Technical Markets, won't pay software firms to port programs over to the Mac II

Homer thinks his competition will come largely from the new PCs based on Intel Corp.'s 32-bit 80386 chip and from the low end of the workstation suppliers' lines. Most workstations, including the Mac II, are powered by Motorola Inc.'s 32-bit 68020 chip. But before Apple can make any inroads in the $2.7 billion U.S. workstation market, it must contend with leaders like Sun, which already has some under-$10,000, 68020-based workstations, and is bringing out a 386-based model as well.

In addition, Apple may also have to go head-to-head with its old PC nemesis in the office market — IBM. Big Blue — although it now only has about $100 million in workstation sales, making it the sixth-largest U.S. supplier — believes it can be a bigger force in the engineering market through its PS/2 family and RT PC workstation. But, Sculley says, for the time being, he isn't very worried about either IBM or its clones — thanks, in large part, to IBM's decision to switch from its old operating system on the IBM PC, DOS, to a newer and largely incompatible operating system, OS/2.

"The DOS world is going through a massive transition," Sculley says. "My sense is that the transition is going to take considerably longer than most people have speculated, because of the large investment [in DOS] that already exists."

Sculley may be underestimating the OS/2 momentum, but he has the marketing bag of tricks to make the most of Apple's customer loyalty. At Pepsi, Sculley headed up the "Pepsi Challenge," and outfoxed Coke by inventing the 12-pack and the 32-ounce bottle. "Nullify a competitor's strength by changing the ground rules," Sculley wrote in his autobiography-cum-management textbook, *Odyssey*. He also wrote, "Marketing is, after all, theater." Consequently, Apple spent more on advertising than on R&D by a margin of over two-to-one when launching the original Macintosh, although Sculley now admits that was a mistake. Even so, for fiscal 1987, Apple spent $222 million overall on advertising and public relations, versus $192 million on R&D across its entire product line.

But no matter how much Apple invests in the Mac II, it's clear that the machine, in order to be successful, must also find third-party software

Lane Erickson

Here comes Digitapple?

When Kenneth Olson, Digital Equipment Corp.'s CEO, announced a joint development agreement with Apple Computer Inc. in January, he said it was something he and Apple CEO John Sculley had been talking about over the course of four Maine vacations. So far, however, the joint effort has yet to yield tangible results.

In fact, many third-party software vendors and competitors are skeptical that the DEC/Apple alliance really means anything at all. "It's really positioning, more than anything else. Do you think you'll ever see a product out of it?" asks David Saykally, president of software maker Unify Corp. Peter Hamilton, a marketing exec for Hewlett-Packard Co., calls it "a marriage of convenience because DEC doesn't have a PC strategy."

And, in terms of workstations, it's doubtful that the alliance will ever produce a joint product or marketing arrangement. DEC has its own very successful workstation, the VAXstation family. And as VAXstation prices drop, "they are starting to compete with PCs," concedes DEC's vice president of Business and Office Information Systems, Henry Ancona.

So for the time being, says DEC vice president Dominic LaCava, Digital and Apple will engage in a little "friendly competition" for the engineer's desktop. Asked if that is where DEC will compete most with Apple, LaCava replies: "I think the customers will determine that." □

vendors who want to write scientific and engineering programs for it. At Motorola, for example, Martin Kalfus, a senior design engineer in Phoenix, uses his Mac II for CAD, designing the packages for transistors and zener diodes with software from Micro CAD/CAM Inc. And down the hall, Zohar Raz, a systems engineer for Motorola's World Marketing group, does circuit board layout on his Mac. But the two, although loyal Mac fans, point out areas that Apple will have to work on before it wins any workstation wars.

Needed: smooth software

First, they say, Apple will have to attract some sophisticated software. Raz admits that the boards he designs are small, with "not such intensive requirements." And he uses his Mac mostly for doing presentation work. "It's not true engineering," he says, "but it's kind of helpful. There would be no other way to do it." He says the heavy-duty design engineering is done on Apollo Computer Inc. workstations with software from Mentor Graphics Inc. "The software support [for the Mac II] was a lot slower than I had hoped," adds Kalfus. "Probably because it's much more difficult to write programs for it."

Other Mac customers paint much the same picture. "We have them in engineering, but we use them for product scheduling," says Lawrence Lunetta, a vice president at Ridge Computers. And James Clark, chairman of Silicon Graphics Inc., which also makes workstations, says: "I have one in my office and one at home. I use them for what everybody else uses them for — as word-processing systems."

Others, like Charles Foundyller, president of Cambridge, Mass., market research firm Daratech Inc., chide Apple for being too protective of its technology — making it difficult for Apple-compatible computer makers to enter the market. Until that happens, he says, there won't be a lot of engineering software available to run on Apple's operating system. "Apple's guarding the Mac like Pepsi guards its formula. It's the syrup-formula mentality," he says. (Apple filed suit in federal court in March, charging Hewlett-Packard and Microsoft Corp. with infringing on copyrights involving the Mac user

Dueling CEOs

In its quest to capture the engineer's desktop, Apple Computer Inc. is on a collision course with Sun Microsystems Inc., the workstation leader. And don't think Sun doesn't have its eye on the PC market, as well.

Sun originally based all its workstations on the same chip Apple now uses. But Sun is now attempting to set a Unix standard with its "Sparc" RISC chip. Sun will license Sparc to anybody, even rival computer companies. The idea is that software companies will then have an easier time writing software for the broadest number of computers.

ELECTRONIC BUSINESS *recently interviewed both Apple CEO John Sculley and Sun CEO Scott McNealy. Apparently, there's little love lost between the two companies.*

Michael Witte

JOHN SCULLEY	SCOTT McNEALY
On the low end	
"[The under-$10,000 workstation market is] going to require that you have more than just a cut-down version of the larger machine." (JS)	"[To get to the low end of the workstation market], all we have to do is drop down in cost, which means riding the experience curve down. We have gravity working for us. We're rolling downhill. [Apple is] pushing stuff uphill. (SM)
On distribution	
"The under-$10,000 market is going to require resellers, and we understand the reseller structure. A direct sale is just going to be too expensive." (JS)	"[Apple] just doesn't have a direct sales channel. And to create one just really challenges the dealers. Whereas if we were to try and create a dealer channel, we won't disappoint them. They already know what they're getting into." (SM)
On computer technology	
"Sun is a very successful company that is starting to fragment its efforts across a number of different architectures." (JS)	"[Apple] has to go through a major technology discontinuity to get to workstations and servers, which means a new operating system, a new CPU architecture, etc. Sun has already stepped through."(SM)

interface.)

However, Apple has never been one to let clone makers climb into its market. Apple built its $2.7 billion, *Fortune* 200 company in a hurry, by keeping ahead of the IBM pack. And the absence of clones has also kept Apple largely immune to price wars and its gross margins above 50%.

In addition, deviating from the pack can also sometimes help business. Apple, for example, recently chose the MIT-designed NuBus as its data pathway, instead of the workstation-standard VMEbus. Sculley says NuBus gives the same performance but is cheaper than VMEbus. And VMEbus is used by at least one other significant player: Texas Instruments Inc. TI and Apple are now co-labeling a Mac II with TI's AI chip inside.

Software, software, software

Still, the Mac II faces a lack of third-party engineering software. Not to worry, Sculley insists — it's coming. "Apple is going to be a significant enough player in this market," Sculley says, "that we will see some very significant products being brought over to the Macintosh platform, just as we've seen some very significant products brought over to the Macintosh platform in the business market in the last year." Adds Homer: "The way you acquire software is to ship systems."

If this approach seem passive, don't be misled. Apple has spent considerable effort on its software, specifically its operating system. Sculley says the constant rewriting of the Mac operating system, while still maintaining compatibilty with earlier versions, is the biggest project Apple has going. There's a $15.5 million Cray Research Inc. supercomputer in Apple's labs that is used to simulate the performance of operating systems, software and new hardware.

In '87, Apple shipped more Mac IIs than Sun's entire installed base

Apple also spent a little over $10 million to adapt Unix, with the help of British software company UniSoft Corp. Apple has done some very clever things with its version of Unix, which it calls "A/UX." For one thing, A/UX retains the famous Mac graphic interface. Sculley says it is the first friendly Unix, and Mac fanatics everywhere applaud. Plus, Apple has built some hooks into A/UX so that if a software developer writes an application program for A/UX, that program only needs to be tweaked to get it running under the Mac operating system. The process also works both ways — Mac operating system programs can theoretically move easily to A/UX. That should encourage developers to take advantage of the installed Mac base. The PC-based CAD leader, Autodesk Inc., just joined the Apple camp, and is working on a more "Macintoshy" version for the future.

Apple won't pay software companies to port programs over to the Mac II — "I don't particularly believe in bribery," Homer says — but it does loan out development equipment and has a staff of 15 software experts to help out developers with code writing.

Distributing the wealth

Another key area Apple has to work on is tuning up its distribution channels. Right now, the rival workstation companies are cultivating new channels of distribution, especially VARs. As the price of workstations slides, making direct sales has become too costly. [See ELECTRONIC BUSINESS March 15, 1988 p64].Here, Apple's established dealer network and its 200 VARs are a plus. Joseph Roebuck, sales vice president for Sun and an ex-Apple employee, admits as much. When asked which company will hound him most in competing for the new channels, Roebuck answers: "I have to assume it's probably Apple for the Mac II. I think they are the primary competition."

But the third-party channels are only beginning to warm to Apple engineering. At National CADD-Pro Inc., a big consortium of engineering VAR/dealers that handles PCs and workstations, members are only just starting to look at the Mac II, according to president Gordon Medlock. Adds Dana Dotson, marketing manager for Douglas Electronics, which sells circuit board design software for the Mac: "It's kind of hard to find Apple VARs."

But Sculley is confident that Apple will get the software it needs to fire up its VARs. Engineering is no backdoor entrance to corporate America for Apple; it is serious business. "Apple doesn't really need to go through the back door anymore, we're walking through the front door," Sculley says. "Engineering is a large enough market by itself to stand on its own. We see a billion-dollar business out there for Apple in the early 1990s, and consequently it's not the back door to anything." □

Can Mac II make it in the CAE world?

The leading computer-aided engineering companies have seen Apple Computer Inc.'s Macintosh II workstation, but so far, they're not impressed. The director of Apple's Technical Markets group, Michael Homer, admits that workstation "requirements are a little bit stiffer," in electronics design. None of the leading CAE players are interested in writing software for the Mac II; all claim to see no demand for it from their customers.

"We've got our hands full with two platforms," says W. Douglas Hajjar, president of Valid Logic Systems Inc. which resells workstations from Digital Equipment Corp. and Sun Microsystems Inc. "Mentor believes in Apollo. Daisy seems to be going with the Sun '386. The three major players are locked up," Hajjar says. "People won't look at Apple unless the box is so great that engineers begin pushing it."

But Andrew Rappaport, president of Boston consultancy The Technology Research Group, thinks that the PC-based CAE companies should jump on the Mac II. Most of those companies are now making the transition to workstations, he says, and might think that Apple was only halfway there. They should think again: "A lot of people want to buy the Mac II rather than a Sun," Rappaport says. "The first viable package on the Mac II is going to do *extremely* well." □

A wild bear-back ride for electronics financiers

Seven months after "Black Monday," electronics firms are finding it's still expensive to raise cash

BY BRUCE C.P. RAYNER

By the end of the day, Joe Costello's worst fears had been realized. Costello, president and chief operating officer of San Jose-based SDA Systems Inc., was planning an initial public offering (IPO) for his firm.

However, the day in question was October 19, 1987 — one of the worst days in the history of Wall Street. And, along with a record 508-point drop in the Dow Jones industrial average, a year's worth of planning and preparation at SDA Systems was instantly erased. Six months later, on February 25, the company, which develops computer-aided design software for chips, announced its intention to merge with ECAD Inc., a Santa Clara, California-based public company in the same business. It was a good fit, but it was not an IPO.

It has not been all bad news, however, for start-up firms planning to go public. Down the road from SDA Systems, Octel Communications Inc. in Milpitas, Calif., also decided to postpone its IPO when the crash hit. But the voice-processing systems company bided its time, and five months later, it was in the vanguard of post-crash companies willing to test the public market waters. According to David Torrey, Octel's director of business development, the March public offering — which raised $16.9 million — was considered a success. Venture capitalists generally agree that Octel did fairly well, but the valuation was a far cry from what it could have achieved had it gone public prior to the crash.

At the same time, Black Monday has also left its mark on the venture capital community. Venture capitalists today remain uncertain as to the short-term future of their mature investments. Most pundits agree that there is little chance of a quick return to the kinds of high valuations common in the bull market that preceded October 19. However, there is some optimism that the market is improving. Jonathan Bayless, a general partner in the Dallas-based venture firm of Sevin Rosen Bayless Borovoy, expects the IPO market to be back within the next few months. Still, since the crash, there has only been a handful of IPOs, a far cry from the 80 in the first nine and a half months of 1987, as reported by Venture Economics Inc., a market research firm in Wellesley, Mass.

Traditionally, IPOs have been the most common method by which venture capitalists cash in on their investments. But now, companies are either postponing the decision to go

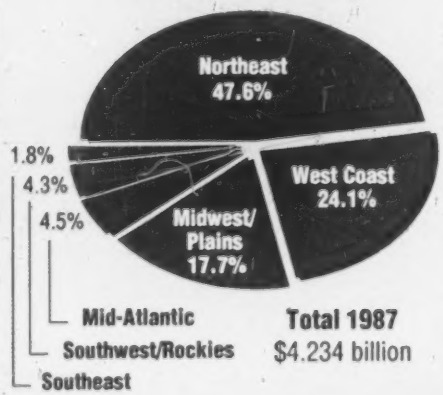
More money is chasing more ideas...

Private venture capital investment
($ billions)

Source: Venture Economics

...but only in some regions...

Regional distribution of capital commitments
(percentage of distribution)



Source: Venture Economics

...and only for some segments of electronics

Ranking of capital commitment preference in 1987
(percentage)

1. Software
2. Communications
3. Medical instrumentation
4. Computers
5. Semiconductors
6. Production equipment
7. Military electronics
8. Automatic test equipment

Source: ELECTRONIC BUSINESS

public or else searching out other more lucrative options. In a survey of venture capitalists conducted by ELECTRONIC BUSINESS earlier this year, almost 95% of the respondents believed the October crash would force companies to postpone decisions to raise equity capital. Similarly, 78% expected the number of strategic alliances, joint ventures, mergers and acquisitions to increase. (Of the 370 venture capitalists whom we queried by mail, a total of 59 responded — for a response rate of 16%.)

Later stage opportunities

From the venture capitalist's point of view, of course, there is no denying that good deals can be found in electronics — especially if the investors are willing to diversify into later stage companies. Even for second- and third-stage financings, venture capitalists have been able to get better prices on their investments as values have come down. There is, however, still a difference of opinion among venture capitalists as to whether values will come down even further. "Right now, the market looks better than it has for the last 18 months," insists Paul Hogan, president at BancBoston Ventures Inc.

There is more action in the leveraged buy outs (LBOs) market too, as both banks and venture capitalists look for ways to diversify their portfolios. While banks invest in LBOs as a way to generate cash flow through the sale of assets, venture capitalists are increasingly looking for growth-oriented LBOs. John Baker, vice president and general partner at Alan Patricof Associates Inc. in New York City, calls these companies "growth buy-outs." Instead of the traditional 10-to-1 ratio between debt and equity, Baker says he prefers to over-fund growth buy-outs with equity — at a ratio as high as 4-to-1, or even 2-to-1. In that way, if growth materializes, the return is good and the company can more manageably service its debt.

Unlike the LBO market, the mezzanine market — that stage of financing right before a company is taken public — is still pretty dry, says Bayless of Sevin Rosen Bayless Borovoy. The reason is that companies looking for mezzanine financing are holding out for pre-crash valuations. However, in most cases, institutional and venture capital investors are not willing to accomodate these companies.

For earlier stage deals, such as seed and start-up companies, venture capitalists remain bullish about the general health of the market. For the most part, it is these fledgling companies that are the bread and butter of the venture capitalists' business. Because most early stage investments can range between five and 15 years in duration, the state of the stock market and economy have less of an impact on their valuations.

According to our ELECTRONIC BUSINESS survey of 59 venture capitalists, 67% of those responding said they expect to increase their total investments in 1988. Considering that Venture Economics reports a record $4 billion increment in capital commitments to private venture funds in

Top 10 U.S. venture capitalists

1987 figures	Total investment in electronics ($ millions)	Electronics investment as a percentage of total	Average electronics investment per deal ($ millions)
TA Associates	$31.5	60%	$1.2
New Enterprise Associates	$28.4	54%	$0.6
Warburg Pincus Ventures	$26.0	7%	$2.8
Oak Investment Partners	$22.3	72%	$5.9
Raytheon Ventures	$22.0	88%	$2.7
Sequoia Capital	$21.4	69%	$1.0
Summit Ventures	$19.2	60%	$1.7
Menlo Ventures	$18.0	82%	$1.0
Merrill Lynch Venture Capital	$16.5	85%	$1.5
J.H. Whitney & Co.	$15.9	52%	$0.8

Source: ELECTRONIC BUSINESS

1987, there is every reason to believe that investments will indeed increase. However, only 11% of the venture capitalists surveyed characterize opportunities in the U.S. computer and electronics industry as "excellent." The majority believe electronics will perform a little better than average in the remainder of 1988. Still, 54% expect to increase their investments in electronics companies in 1988. Software ranks at the top of the list in terms of where the most start-up activity will occur in 1988 — with communications a close second.

Most venture capitalists also agree that high tech is not the darling of the venture capitalist that it was earlier in the decade. "Venture capitalists are taking a broader view of life now," admits Gary Stoltz, partner at Pathfinder Venture Capital Funds, a Minneapolis-based firm with funds totaling $73 million.

Shifting emphasis

Overcompetition and overcapacity in the computer and peripherals business have specifically turned a lot of venture capitalists away from hardware. And with many of the 1980-vintage electronics companies coming to market with new products this year, the options for start-ups look less sanguine. As a result, Stoltz says that Pathfinder's fund has shifted from 70% electronics in 1980 to just 40% today. Similar shifts are reported from other firms, with the emphasis moving toward biotechnology, medical instrumentation and services, as well as specialized retailing.

Stephen Gaal, a partner in the Boston-based venture capital firm of TA Associates, with funds between $400 million and $500 million, agrees that diversification of investments is more common. Still, TA Associates is focusing more on high-tech start-ups these days, says Gaal.

Traditionally, start-ups operate in more of a "narrow band" of valuations than do later stage companies, and now start-ups are valued at the lower end of that band, he says. Gaal is currently interested in optical disk technology and low-priced 32-bit workstations. As with other venture capitalists, software and networking are also high on his list of markets to watch.

The flow of deals in electronics is little changed from the pre-crash market, most venture capitalists say, but the jury is still out as to whether the quality is still up to snuff. "Operationally, we get as many deals through the door as we did before, and they seem to have the same characteristics," says David Gold, a general partner with Indosuez Ventures in Menlo Park, Calif., which is a subsidiary of Paris-based Banque Indosuez. Gold favors vertical market companies that focus on a niche by offering application-specific solutions built around other vendors' hardware and software.

But David Dunn, a managing partner with Idanta Partners in Fort Worth, Texas, chairman of Prime Computer Inc., and a 25-year veteran of the venture capital business, does not agree that high-tech business is easy to find. "I think it is harder to make good investments in the computer industry than it was 20 years ago because of shorter product life cycles. If you miss development time by one year now, you are out of business," he says. Still, Dunn remains bullish on electronics.

High tech is no longer the darling of the venture capitalist

As for where in the United States that money is being made, the most successful location for venture capitalists is still California. Richard Florida, assistant professor in the School of Urban and Public Affairs at Carnegie Mellon University, insists that California will continue to exert a strong magnetism for start-ups because the venture capital infrastructure is so well developed. More and more, East Coast venture capitalists will find it essential to set up a California office if they expect to compete, he says. Besides California, he also favors Minneapolis-St. Paul as a region to watch.

On the national level, the Tax Reform Act of 1986 continues to be a hotly debated issue among venture capitalists. While some insist that the increase in the capital gains tax rate from 20% to 28% has had an effect on their willingness to invest in start-ups, others contend that the tax consequences are largely inconsequential. "I think the issue of a loss of preferential treatment is a bit of a red herring," says venture capitalist Gold. "The fact of the matter is that it will have a negligible impact on the industry of venture capital."

Stoltz, at Pathfinder, insists that tax reform has had a depressing effect on his firm's start-up activity. Combining the strong stock market in 1987 with the higher capital gains rate left Pathfinder with 25% less in start-up activity, he says. Another issue that Stoltz finds discouraging is the change in the net operating loss (NOL) carry-forward as a result of the tax bill. As of last year, NOL carry-forwards could no longer be applied against the acquiring company's taxes to the same extent as before.

From a political perspective, the only presidential candidate to publicly state a willingnesss to reduce the capital gains tax has been Vice President George Bush. If elected, Bush says he will lower the rate to around 15%. This is in the range that would maximize tax revenue, some economists argue. However, very few venture capitalists are changing their investment plans because of the upcoming election. □

Who's who in venture capital

In a year when America's economy was quaking on a Wall Street fault line, most U.S. venture capitalists continued to invest in high technology — welcome news for electronics executives seeking funding for their fast-growing companies.

Recognizing that these executives need up-to-date information on the venture capital firms that are ready to provide that funding, ELECTRONIC BUSINESS has assembled its annual directory of the venture capitalists that best serve the electronics industry.

The following is a report card of financial data provided by the venture capital firms that responded to the ELECTRONIC BUSINESS survey. It includes for each firm the 1987 figures for their total paid-in capital, total investment and total number of deals.

MARY DONOVAN

1987 figures **Company** Contact, telephone	Address	**Total paid-in capital** ($ millions)	**Dollar investment** ($ millions) Total	Electronics	**Number of companies invested in** Total	Electronics	**Preferred stage of investment**
Advent International Corp. Tom Laller: (617) 574-8400	45 Milk Street, Boston, Mass. 02109	NA	NA	NA	NA	NA	NA
Albert-Berman Capital Corp. Marty Albert: (818) 889-5565	31308 Via Colinas, Suite 107, Westlake Village, Calif. 91362	NA	NA	NA	8	6	First, second, third or mezzanine
American Research & Development Jan Moran: (617) 423-7500	45 Milk Street, Boston, Mass. 02109	$62	$12	$5	18	8	Seed, first, second
Asset Management Co. Craig Taylor: (415) 494-7400	2275 East Bayshore Road, Palo Alto, Calif. 94303	$90	$9.8	$6.1	21	10	Seed, first
BancBoston Ventures Inc./BancBoston Capital Inc. Paul F. Hogan (Ventures): (617) 434-2442 Frederick M. Fritz (Capital): (617) 434-2442	100 Federal Street, Boston, Mass. 02110	$145	$67.3	$4.1	37	11	First, second, third or mezzanine, follow-on
Battery Ventures Richard Frisbie: (617) 367-1011	200 Portland Street, Boston, Mass. 02114	$35	$9	$9	8	8	First, second, third or mezzanine, follow-on
Bay Partners Chuck Hazel: (408) 725-2444	10600 North De Anza Boulevard, Cupertino, Calif. 95014	$105	$6	$6	9	9	Seed, first, second, follow-on
Berry Cash Southwest Partnership Berry Cash: (214) 329-7279	13355 Noel Road, Suite 1375, Dallas, Texas 75240	NA	NA	NA	NA	NA	NA
Brentwood Associates G. Bradford Jones: (213) 826-6581	11661 San Vicente Boulevard, Suite 707, Los Angeles, Calif. 90049	$294	$30.6	$11.7	33	17	No preference
Capital Relations Inc. Robert Cosgrove: (805) 379-0790	4055 East Thousand Oaks Boulevard, Suite 215, Westlake Village, Calif. 91362	$65	$10	$10	4	4	Seed, first
Charles River Ventures Richard M. Burnes: (617) 429-0477	67 Batterymarch Street, Boston, Mass. 02110	NA	$24.4	$8.1	23	14	No preference
Chatham Venture Corp. Euan Malcolmson: (617) 863-0970	450 Bedford Street, Lexington, Mass. 02173	$25	$2.3	$2.3	4	4	Seed, first
Charter Ventures A. Barr Dolan: (415) 325-6953	525 University Avenue, #1500, Palo Alto, Calif. 94301	NA	NA	NA	12	6	No preference
Citicorp Venture Capital Ltd. Thomas C. Darling: (212) 559-1127	153 East 53rd Street, 28th floor, New York, N.Y. 10043	$500	$200	$5	15	2	First, second

(Continued)

DIRECTORY OF VENTURE CAPITAL FIRMS

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
Cornerstone Ventures (formerly Rothschild Unterberg Towbin Ventures) J. Michael Gullard: (415) 854-2576	3000 Sand Hill Road, Building 3, Suite 260, Menlo Park, Calif. 94025	$0	$2.5	$0.4	5	1	First, second
Crosspoint Venture Partners John B. Mumford: (415) 964-0100	1951 Landings Drive, Mountain View, Calif. 94043	$65	$16	$14.5	17	14	Seed
Dajen Consulting Corp. Robert Cohen: (201) 947-4945	9 Lundy Lane, Larchmont, N.Y., 10538	NA	NA	NA	NA	NA	NA
Dougery, Jones & Wilder Jeanne M. Mitchell: (415) 968-4820	2003 Landings Drive, Mountain View, Calif. 94043	NA	NA	NA	NA	NA	NA
In Texas: A. Lawson Howard: (214) 960-0077	Three Lincoln Centre, 5420 LBJ Freeway, Suite 1600, Dallas, Texas 75240	$86.5	$16.2	$2.5	27	3	No preference
Eastech Management Company Inc. M. Shanahan: (617) 338-0200	One Liberty Square, Boston, Mass. 02109	$34.3	$2.3	$1.5	4	3	Seed, first, second
Euclid Partners Corp. Frederick Wilson: (212) 489-1770	50 Rockefeller Plaza, Suite 1022, New York, N.Y. 10020	$36	$2.3	$1.6	9	6	First, second
Fairfield Venture Partners E. E. Pettinelli: (203) 358-0255	1275 Summer Street, Stamford, Conn. 06905	$100	$11	$4.5	More than 20	More than 10	Seed, first, second
First Century Partners David S. Lobel: (212) 698-6108	1345 Avenue of the Americas, New York, N.Y. 10105	$121	$7	$3	6	3	No preference
Franc & Associates Paul Franc: (619) 729-9372	353 Tamarack #B, Carlsbad, Calif. 92008	NA	NA	NA	NA	NA	NA
Grace Ventures Corp. Robert E. Pedigo: (408) 725-0774	20300 Stevens Creek Boulvard, Suite 330, Cupertino, Calif. 95014	$64	$7	$4	19	13	Seed, first, second, follow-on
Hambro International Venture Fund Fran Janis: (212) 288-7778	17 East 71st Street, New York, N.Y. 10021	$150	$10.2	$6	15	10	Seed, first
Heritage Capital Corp. G. Kinsey Roper: (704) 334-2867	2095 Two First Union Center, Charlotte, N.C. 28282	NA	NA	NA	NA	NA	NA
Hill, Kirby & Washing John G. Hill: (303) 442-5151	885 Arapahoe Avenue, Boulder, Colo. 80302	$6	$5.7	$3.6	9	7	Seed, first, second
IAI Venture Capital Group Noel P. Rahn: (612) 371-7935	1100 Dain Tower, P.O. Box 357, Minneapolis, Minn. 55440	NA	$3.8	$2.2	10	4	No preference
Idanta Partners Dev Purkayastha: (817) 338-2020	201 Main Street, Suite 3200, Fort Worth, Texas 76102	NA	NA	NA	NA	NA	NA
Indosuez Technology Group David E. Gold: (415) 854-0587	3000 Sand Hill Road, Building 2, Suite 160, Menlo Park, Calif. 94025	None	$3.6	$1.4	16	9	No preference
Intersouth Partners Joe Velk: (919) 544-6473	P.O. Box 13546, Research Triangle Park, N.C. 27709	$6.5	$4.8	$2.5	10	5	No preference
Interwest Partners Chuck McMinn: (415) 854-8585	3000 Sand Hill Road, Bldg. 3, Suite 255, Menlo Park, Calif. 95025	$135	$16.4	$7	28	14	No preference
JAFCO America Ventures W.E. Shelander: (415) 854-0746	2180 Sand Hill Road, #320, Menlo Park, Calif. 94025	NA	$2	$1.5	3	2	First, second, third or mezzanine, follow-on

(Continued)

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
J.H. Whitney & Co. Edward Ryan: (212) 757-0500	630 Fifth Avenue, Room 30200, New York, N.Y. 10111	NA	$30.8	$16.0	34	20	No preference
Kimberly, Brunell & Lehmann Inc. David A. Shaw: (202) 833-9031	1025 Thomas Jefferson Street, Washington, D.C. 20007	$0.5	Over $1	Over $1	Over 5	Over 5	No preference
Kleiner Perkins Caufield Byers Dina Downey: (415) 421-3110	4 Embarcadero Center, Suite 3520, San Francisco, Calif. 94111	$42.5	$33.8	NA	33	26	Seed, first
The Lambda Funds/Drexel Burnham Lambert Inc. Alexandra Mahnken: (212) 480-6018	55 Broad Street, 15th floor, New York, N.Y. 10004	$40	$6.0	$4.1	15	10	Second, third or mezzanine, follow-on
Lawrence, Tyrrell, Ortale & Smith Brian Horey: (212) 826-9080	515 Madison Avenue, New York, N.Y. 10022	$68	$13.2	$2.9	17	4	Seed, first, second, third or mezzanine
Leverage International Inc. C. Wasserman: (301) 230-0701	P.O. Box 2073, Potomac, Md. 20852	NA	NA	NA	NA	NA	NA
Mayfield Fund Norman Fogelsong: (415) 854-5560	2200 Sand Hill Road, Suite 200, Menlo Park, Calif. 94025	$350	$23.7	$14.3	28	16	No preference
Menlo Ventures DuBose Montgomery: (415) 854-8540	3000 Sand Hill Road, Building 4, Suite 100, Menlo Park, Calif. 94025	$150	$22	$18	20	18	Seed, first
Merrill Lynch Venture Capital Kelly Pan: (212) 980-0462	717 Fifth Avenue, 22nd floor, New York, N.Y. 10022	$120	$19.5	$16.5	13	11	Seed, first, second, third or mezzanine
Merrill, Pickard, Anderson & Eyre W.J. Pickard: (415) 856-8880	2 Palo Alto Square, Suite 425, Palo Alto, Calif. 94306	NA	NA	NA	NA	NA	NA
Mohr, Davidow Ventures Peter A. Roshko: (415) 854-7236	3000 Sand Hill Road, 1-240, Menlo Park, Calif. 94025	$80	$3.6	$1.9	8	5	Seed, first
Morgan Holland Ventures Corp. James F. Morgan: (617) 423-1765	One Liberty Square, Boston, Mass. 02109	$58.5	$5	$1	4	2	Seed, first
Morgenthaler Ventures T.A. Laufik: (216) 621-3070	700 National City Bank Building, Cleveland, Ohio 44114	More than $100	$10.7	$3.9	21	8	No preference
New Enterprise Associates Charles W. Newhall: (301) 244-0115	1119 St. Paul Street, Baltimore, Md. 21202	$386	$53	$28.4	78	48	Seed, first
Oak Investment Partners A. Merrill Ayers: (203) 226-8346	1 Gorham Island, Westport, Conn. 06880	$217	$31.2	$22.3	46	38	Seed, first
Pathfinder Venture Capital Funds A.J. Greenshields: (612) 835-1121	7300 Metro Boulevard, Suite 585, Minneapolis, Minn. 55435	$72.6	$8.3	$3.2	15	4	No preference
Raytheon Ventures D.S. Dwelley: (617) 860-2270	141 Spring Street, Lexington, Mass. 02173	NA	$25	$22	9	8	No preference
Robertson Colman Stephens Venture Fund Mari Coale: (415) 781-9700	One Embarcadero Center, Suite 3100, San Francisco, Calif. 94111	$150	$24	NA	24	7	No preference
SAS Associates T. Michael Christiansen: (213) 624-4232	515 South Figueroa Street, #600, Los Angeles, Calif. 90071-3396	NA	$4.5	NA	15	8	Second, third or mezzanine, follow-on
Scientific Advances Veronica Payer: (614) 294-5541	601 West Fifth Ave., Columbus, Ohio 43201	NA	NA	NA	NA	NA	NA
Sequoia Capital Don Valentine: (415) 854-3927	3000 Sand Hill Road, Building 4, Suite 280, Menlo Park, Calif. 94025	$300	$31	$21.4	37	22	No preference

(Continued)

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
Shaw Venture Partners Alan Dishlip: (503) 228-4884	851 S.W. Sixth Avenue, Suite 800, Portland, Ore. 97204	$50	$1.5	$1.4	7	6	Seed, first, second
Sigma Partners Cliff Haas: (408) 279-6300	2099 Gateway Place, Suite 310, San Jose, Calif. 95110	$33	$8	$7.3	12	11	Seed, first, second, follow-on
In Massachusetts: Gardner Hendrie: (617) 393-7396	342 Green Street, Northboro, Mass. 01532						
Southern California Ventures B. Allen Lay: (213) 216-0544	9920 Lacienega Boulevard, Suite 510, Inglewood, Calif. 90301	$12	$3.7	$1.7	8	4	Seed, first
Southwest Enterprise Associates, LP Leland Murphy: (214) 991-1620	5420 LBJ Freeway, 1266-2 Lincoln Centre/LB41, Dallas, Texas 75080	0	$2.6	$2.6	7	7	Seed, first, second
Summit Ventures Sarah Greene: (617) 742-5500	1 Boston Place, Boston, Mass. 02108	$119.7	$32	$19.2	22	11	First, second
Sutter Hill Ventures Tench Coxe: (415) 493-5600	2 Palo Alto Square, Site 700, Palo Alto, Calif. 94306	$110	$10	$4	8	4	Seed, first, second
TA Associates P. Andrews McLane: (617) 338-0800	45 Milk Street, Boston, Mass. 02109	$512	$52.6	$31.5	33	26	No preference
In New York: Jacqueline C. Morby: (212) 230-9870	147 East 48th Street, New York, N.Y. 10017						
In California: Jeffrey T. Chambers: (415) 328-1210	435 Tasso Street, Palo Alto, Calif. 94301						
3i Ventures Fred M. Haney: (714) 720-1421	450 Newport Center Drive, Newport Beach, Calif. 92660	NA	$13	$7	16	11	Seed, first, second, follow-on
Trinity Ventures Limited Noel Fenton: (408) 446-9690	20813 Stevens Creek Blvd., Suite 101, Cupertino, Calif. 95014	$10.1	$6.9	$3.3	11	8	No preference
TVM Techno Venture Management Peter A. Schober: (617) 574-8406	45 Milk Street, Boston, Mass. 02109	$100	$14.4	$12.1	13	10	First, second, third or mezzanine, follow-on
U.S. Venture Partners Steven M. Krausz: (415) 854-9080	2180 Sand Hill Road, Suite 300, Menlo Park, Calif. 94025	NA	NA	NA	NA	NA	NA
Vast Company Inc. Peter F. Lai: (704) 527-1537	500 Archdale Drive, Box 70, Charlotte, N.C. 28217	NA	NA	NA	NA	NA	NA
The Venture Capital Fund of New England Karen Reiche: (617) 439-4646	160 Federal Street, 23rd floor, Boston, Mass. 02110	[illegible]	$4.54	$1.5	13	3	First
Venture Funding Group Allan E. Skora: (212) 691-9895	49 West 12th Street, Executive Suite, New York, N.Y. 10011	NA	$9.4	$5.3	8	5	No preference
Wachtel & Company Inc. John D. Sanders: (202) 898-1144	1101 14th Street N.W., Washington, D.C. 20005	$5	$5	$4.8	5	3	Seed, first, second
Warburg Pincus Ventures Chris Browdy: (212) 878-0600	466 Lexington Avenue, New York, N.Y. 10017	$1,600	$375	$26	50	9	Seed, first
Woodside Fund Vincent M. Occhipinti: (415) 368-5545	850 Woodside Drive, Woodside, Calif. 94062	$30 (approx.)	NA	NA	NA	NA	Seed, first, second
Yamaichi Univen Company Ltd. Ms. Atsuko Fisher: (213) 626-1064	333 South Hope Street, Los Angeles, Calif. 90071	$1.6	$100	NA	NA	NA	No preference
Xerox Venture Capital L.J. Harris: (203) 968-3383	800 Long Ridge Road, Stamford, Conn. 06904	$55	$11.5	NA	18	NA	Seed, first

The PC market in Japan: Where's IBM?

In a crowded field of competitors, IBM has failed to wow the Japanese PC market. Will the PS/2 make a difference?

BY SHONEI KURITA

Japan has long been an ugly chink in IBM's armor. Big Blue, the world's largest computer company, does not have anywhere near the market dominance in Japan that it does in other countries, particularly in regard to personal computers.

According to a survey by the *Japan Economic Journal*, NEC Corp. ruled the Japanese personal computer market in 1986 by seizing a 51.3% share. At a distant second was Fujitsu Ltd., which controlled 15.2% of the market in terms of units produced. IBM Japan Ltd. came in third with a mere 7.0%, followed by Toshiba Corp. with 6.5% and Seiko Epson Corp. with 6.2%. Other companies accounted for the remaining 13.8%.

In terms of 16-bit machines, NEC's hegemony is even stronger. The Tokyo-based corporation owns roughly 90% of that market, according to various sources.

IBM Japan first started selling its 5500 Multistation PCs to the Japanese market five years ago. Last year, the company announced an upgraded series named Personal System/55. The announcement came just two months after Big Blue's U.S. introduction of PS/2 in April of 1987. The PS/55's top-end Model 70 similarly incorporates the Intel Corp. 80386 microprocessor, as does IBM's high-end PS/2 PC in the United States. And, not surprisingly, IBM's Japanese PCs also run on the same OS/2 software.

The new machines will help IBM better penetrate the PC market in Japan, asserts Kazufu Hotta, a director of workstation marketing. "As ICs have been regarded as the rice or oil of industry in the 1970s and 1980s," he says, "I think the Personal System will be integrated into every industry as a box with an operating system in the 1990s. There is one user, for example, who wants to integrate our PS/2 with OS/2 into their electronic microscope products."

By using Systems Application Architecture, Hotta asserts that IBM will standardize the user interface among all Big Blue computers, from large mainframes to personal computers. This, contends Hotta, will insure the compatibility of applications software on a worldwide basis. And because PS provides a unified interface for end users, IBM Japan's new PCs have gained quick acceptance in the marketplace, according to Hotta. "Nihon Insurance, for example, decided to install 5,500 PS/55s, in addition to 1,700 system 36s, in the coming year," he says. "And our installations will expand."

IBM Japan's PCs are not mere imports from the United States, but rather, "Japanized" versions of them.

Norio Hasewaga

IBM Japan's Hotta: "I think the Personal System will be integrated into every industry . . . in the 1990s"

"Five years ago," says Hotta, "we answered the advanced requirements of Japanese users who demanded high resolution graphics of 24 by 24 dots as well as Kanji [Chinese ideogram] processing . . . with the capabilities of computation, word processing and communication."

This technology, which was developed for the Japanese market, has been extremely useful elsewhere, according to Hotta. "Recently in the U.S.," he says, "users' requirements have been shifting to the same level of high-resolution image or graphic processing. So we globally named our new products as Personal System by using the same parts."

Furthermore, Big Blue recently announced a powerful laptop computer which was developed in Japan. "Our Yamato Laboratory will play an important role in IBM's worldwide laptop products," boasts Hotta.

In addition to the Japanized PS/55 series, Big Blue sells imported PS/2s in Japan, mainly to the subsidiaries or branches of foreign multinational companies. At the same time, IBM Japan exports its PS/55s to the foreign subsidiaries of Japanese multinational corporations.

Indeed, Big Blue has done well in the business environment. When limiting the 16-bit PC market to the corporate end-user, another *Japan Economic Journal* survey of 711 companies showed that the highest market share belonged to IBM. Big Blue's 26.6% share was followed by Fujitsu's 24.8%; Hitachi Ltd.'s 21.3%; NEC's 11.5%; Nippon Univac Kaisha Ltd.'s 6.4%; Burrough Company Ltd.'s 3.4%; and NCR Japan Ltd.'s 3.1%. Other various companies made up the remaining 2.9%. The total units shipped to this market segment in Japan was about 2 million in 1986. In addition to a salesforce of 3,000 employees, IBM Japan now

Norio Hasewaga

NEC's Watanabe: "We use the Intel microprocessors in order to realize more performance"

has 130 marketing agents and VARs to sell its personal computers and System 36 products.

NEC's 90% share

IBM will need the additional marketing muscle to challenge NEC, a company widely acclaimed to own 90% of the 16-bit Japanese PC market. NEC executives, however, downplay their near monopoly. "We actually do not own such a large share," insists Kazuya Watanabe, an NEC vice president. "If you look at the marketplace only on the basis of the major dealers' shops, we have 90% in terms of units sold. However, NEC's share in the entire 16-bit market is between 65% and 70%. And if you look at the total PC market, including 8-, 16- and 32-bit machines, our share seems to be between 50% and 55% in terms of revenue."

Watanabe predicts that the mainstream of the market will continue to be 16-bit machines for the time being, even if the demand for 32-bit machines surges. "A survey by the Japan Electronic Industry Development Association shows that the annual shipment of 16-bit machines finally surpassed that of 8-bit ones just in 1987," notes Watanabe.

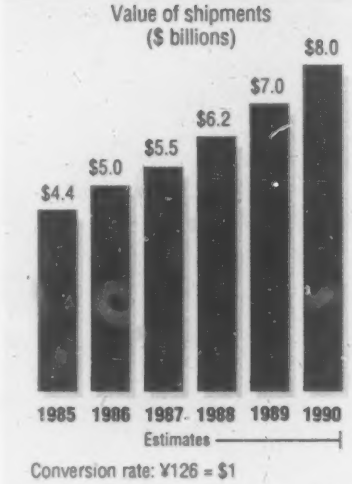
The association's survey also reveals that 40.5% of the machines shipped were used for business purposes, 13% for scientific computation or measuring and control applications, and 46.5% for education, hobby and home usage. NEC's PC9800 and 8800 Series are widely used in all of the end-user market segments, both as standalone machines and as computers in a network. NEC's 5200 Series is challenged by IBM and Fujitsu PCs in the microcomputer to mainframe link (MML) marketplace.

Some of NEC's PCs incorporate *both* the company's own V-series microprocessors and Intel's. Watanabe explains why: "We use our own V-series microprocessors in order to secure the complete compatibility of our software to our previous machines. We use the Intel microprocessors in order to realize more performance." Interestingly enough, Watanabe adds that some of NEC's 32-bit PCs and laptop computers that are manufactured in Boston and Atlanta have been selling well in Japan.

NEC's success in the Japanese PC market has attracted clone makers, much as IBM's success in the United States has attracted the likes of companies like Compaq Computer Corp. of Houston. In fact, three dominant PC groups have arisen in Japan:

- NEC and its clone maker Epson;
- the AX project group which aims at providing a unified Japanized version of the IBM PC/AT. The group is jointly promoted by ASCII, Japan Softbank and Microsoft K.K. Several IBM PC clone makers — including Alps Electric Company Ltd., Kyocera Corp., Mitsubishi Electric Corp. and Sanyo Electric Company Ltd. — are basically exporters and are not a major force in Japan;
- the alliance between Fujitsu and Matsushita Electric Industrial Company Ltd.

Japanese PC market



Conversion rate: ¥126 = $1

Source: Japan Electronics Industry Development Assoc.

Fujitsu's Kuwahara: Sales of our 80386-based PCs have been three times higher than what we expected

Executives at Fujitsu, Japan's No. 1 mainframe vendor, clearly see the PC as an integral part of their overall business. "Low-level machines including personal computers and workstations have very quickly become strong recently, and the future of mainframe computers depends on this trend," asserts Akira Kuwahara, general manager of the marketing promotion division. "The importance of software with open architecture for low-end machines will increase more and more in an MML environment."

Fujitsu is targeting four market segments — big business, education, VARs that are medium-sized software houses, and dealer shops. "In the big business segment, we are going to rapidly supply users with the strong power of our 32-bit 80386 FMR-70 PC which uses OS/2," says Kuwahara. "Our recent sales performance in this segment has been three times higher than our expectation. The growth rate of the entire FMR series last year was 200%." The average growth rate of Fujitsu's FM series, which uses Intel's 80286 and 80186 microprocessors, and Fujitsu's G series, which uses Motorola Inc.'s 68010 and 68020 microprocessors, should be around 35% this year, according to Kuwahara. □

Norio Hasegawa

Motorola stalks the Hong Kong ASIC market

Amid widespread skepticism, Motorola is investing more than $200 million in Hong Kong's ASIC market. Will the gamble pay off?

BY EUAN BARTY

Motorola has the Hong Kong electronics industry abuzz. In a bold move, the company recently announced that it would invest more than $200 million to build a state-of-the-art ASIC manufacturing plant in Hong Kong. The seafront project, christened "Silicon Harbor," will utilize technology one generation ahead of similar facilities now in the United States and Europe, according to C.D. Tam, head of Motorola Semiconductors Asia-Pacific Ltd., a subsidiary of Motorola Inc., headquartered in Schaumburg, Ill.

Tam asserts that Silicon Harbor, conspicuously named after California's Silicon Valley, will act as a catalyst. "Many years ago when the electronics industry was born," he says, "a lot of the pioneering was done in California. . . . By building an advanced semiconductor plant in Hong Kong, we believe that we can generate a similar capability here."

Amid such visionary talk, critics wonder whether Motorola is investing wisely. Somewhat suspect is the company's strategy of using Silicon Harbor primarily to support the local ASIC market which, by most estimates, is tiny. Also questionable is Tam's lofty goal of duplicating Silicon Valley in Hong Kong, a country which will revert to Chinese sovereignty in 1997.

Nonetheless, Motorola remains undaunted. Although the company will not divulge specifics, Tam confides that Silicon Harbor's cost will top $200 million, more than the cumulative amount of money that the company has invested in Hong Kong over the past 20 years. Unofficial estimates within the local industry put the figure higher, at around $300 million. If those estimates are accurate, Motorola will be spending an amount equivalent to 43% of the *total* U.S. investment in Hong Kong's electronics industry for 1986.

C.D. Tam, head of Motorola Semiconductors Asia-Pacific Ltd., is hoping that his company's more than $200 million investment in Silicon Harbor will pay off

Due for completion in two years, Silicon Harbor will be a 300,000 sqare foot plant dedicated to the fully automated production of ASICs, application-specific integrated circuits such as standard cells and gate arrays. The facility will employ 800 people, two-thirds of whom will be professionals or engineers.

How busy the new plant will be is uncertain. Bulent Celebi, product marketing director at National Semiconductor Asia-Pacific Marketing Ltd., estimates that the total ASIC market in Asia, excluding Japan, was worth only $50 million in 1987. According to Celebi, Taiwan accounted for 35%, Korea and Australia 25% each, and other countries — including Hong Kong — shared the remaining 15%.

Such disappointing figures do not faze Tam, who is expecting explosive growth in the marketplace. "The whole world is shifting toward application-specific products. There will be a growing need in the 1990s to provide this technology in Asia," he asserts.

A peanut market

Big deal, says Goh Geok Ling, vice president of Texas Instruments Inc.'s Asia-Pacific division. "The growth rate itself is insignificant because the base is so small. If you have one peanut and then you have two, you've got a 100% growth rate, but it doesn't tell you much about the peanut business."

Still, Tam insists that a huge Asian ASIC market will indeed develop. In particular, he is counting on Hong Kong electronics companies doing

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more systems manufacturing which will require a larger supply of local ASICs. And where will these products be headed? China, says Tam. He points out that with the Hong Kong dollar pegged to the U.S. dollar — making the currencies effectively indistinguishable — it is much cheaper for China to buy products from Hong Kong than from Japan. "Just think how many color televisions will be sold there in the future," he remarks.

The Hong Kong-China link will become increasingly important, especially as 1997 nears. This could explain Motorola's choice of Silicon Harbor's locale. "To Hong Kong manufacturers, it really doesn't matter whether you put it here or elsewhere," says National Semiconductor's Celebi. "But in terms of China support, it's a good idea."

Apparently Motorola has other good ideas as well. Unusual for a Hong Kong manufacturer, the company puts much emphasis on staff relations. It trains new employees straight from school, has a planned job rotation program to relieve tedium and ensure continuity of skills, bases promotions and bonuses on performance, and operates a profit-sharing scheme.

It seems to work. Motorola has a low labor turnover rate which is the envy of other electronics manufacturers in Hong Kong. Tam asserts that employee turnover is only running at around 0.5% each year, even without adjusting for emigration. "Our stability is due to our policy rather than anything else," says Tam.

Nonetheless, Motorola's choice of Hong Kong as the site for a major investment in ASICs may not be prudent. "The primary area of ASIC utilization is logic replacement and there's not a lot of logic to be replaced in Asian applications," asserts National Semiconductor's Celebi.

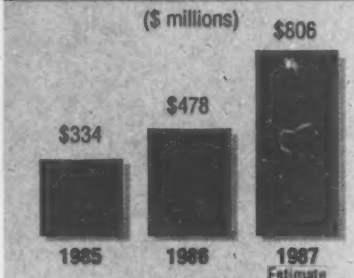
Furthermore, Celebi believes that the structure of Hong Kong businesses will work against the sort of transformation that Motorola's Tam envisages. "To do anything significantly high tech, you're talking large resources and large companies. You can't do it with a 15-man company," says Celebi, referring to the fact that Hong Kong's electronics industry consists primarily of smaller companies.

Celebi is not the only one with doubts. "In Hong Kong, it's very difficult to get highly skilled labor for all levels of fabrication. Also, there is a limited local market, unlike Japan, Korea or Taiwan," argues James N. Chapman, a regional marketing manager for Intel Corp., headquartered in Santa Clara, Calif.

Consequently, Intel will concentrate its efforts elsewhere. "There are opportunities coming up in Taiwan and we believe the market will warrant investment within the next five years," says Chapman.

Still, National Semiconductor's Celebi has not ruled out the possibility of his company expanding in Hong Kong. "Some ideas have been kicked around," he says. "Management has certainly taken note of what Motorola's doing." ☐

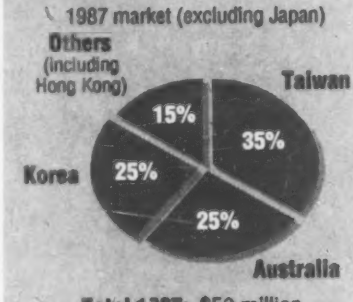
Hong Kong's semiconductor consumption



Source: Dataquest Inc.

Motorola's bet is that Hong Kong's chip use is rising fast — and its use of ASICs is rising even faster . . .

Pacific Rim ASIC market



Source: National Semiconductor Corp.

. . . but it's a huge bet. So far, Asia's ASIC market is tiny

PC fax: The phone is ringing but will anyone answer the call?

Egged on by sales of fax machines, sales of PC fax boards are expected to skyrocket. Suppliers, though, are skeptical

BY LAMONT WOOD

It's a market that has grown from two competitors in 1986 to more than 20 in early 1988, and one in which unit sales are expected to skyrocket by a factor of 10 by 1991.

It's also a market where the participants keep looking over their shoulders as they try to plumb its potential, wondering if they can really bring together two approaches to office automation as far apart as East and West — "fax" machines, and microcomputers.

"Our biggest challenge is to get our dealer base educated. Most computer dealers don't carry fax machines. And there's a tremendous lack of end-user awareness," asserts Joel Port, computer products manager for Panasonic Industrial Co. in Secaucus, N.J. He notes that in one poll, half of the executives questioned thought a fax machine was "some kind of copier."

A fax machine is indeed a sort of long-distance copier. You dial the phone number of the fax machine you want to send to, feed in a document, and the page is scanned and transmitted — in about 25 seconds — to the distant machine, where a facsimile is printed out.

Today's standard fax machines use the Consultative Committee on International Telegraphy and Telephony's (CCITT) Group 3 protocol — digital transmission at 9,600 baud. Since they are all based on the same CCITT protocol, any Group 3 fax machine can send to any other Group 3 machine (and most can send to Group 2 machines as well) anywhere in the world. And since anything on the page — text, graphs, doodles — will be transmitted, in seconds, fax is fast replacing the telex network, with its slow speed and limitation to uppercase letters.

An add-in fax board, which contains a fax modem and the software necessary to control it, enables a personal computer to become its own fax machine. Depending on the software, documents generated on the PC can be sent directly to a fax machine, without the intermediate step of being printed on paper. Using a variant of optical character recognition software, fax images received by the PC can be turned into text files.

There is black magic in combining digital and analog on a PC fax board

The advantages? Price is no longer one of them. PC fax boards average about $1,000, but "street prices" for entry-level standalone fax machines have fallen to that level and even lower. Some PC fax boards cost less than $500, but they are using 4,800 baud or even 2,400 baud modems. They operate normally, since these are speeds that fax machines would "step down" to under bad line conditions, but transmission times — and phone bills — are proportionally higher.

"Broadcasting" — sending to multiple recipients — is usually cited as the major advantage of these PC fax boards. This capability is otherwise only available on the higher end fax machine costing $2,500 and up.

"An example would be a sales manager who has a bulletin he wants to get out to the salesforce," says Jim McNaul, vice president of strategic planning at Datacopy Corp. of Mountain View, Calif. "He can compose the document on the PC, reference it to a standard list of sales offices, and schedule transmission for that night when rates are lower. The next morning it will be at each office."

But the boards' disadvantages may overshadow their appeal. "The only folks we recommend purchasing these boards are "information brokers" — those [who are] dependent on large amounts of information, use a PC and don't want to leave their desks," says Shelly Bakst, senior analyst at International

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Data Corp., a market research firm in Framingham, Mass.

"There are too many frustrations for those who don't depend on PC-based systems. You have to install the board. Most people only have half-page displays. It can take 10 minutes to print out the image that it took only 25 seconds to receive. You need a dedicated phone line and you need to leave your PC on to receive incoming faxes. And to make good use of the board, you need a document scanner, and those cost $2,000 to $3,000," notes IDC's Bakst. "And standalone fax is very simple to use."

Nevertheless, fax boards are finding a following. Sales have grown from raw beginnings in late 1985 to 16,555 units, worth $19 million, in 1987, and are expected to reach 188,000 units, worth $75 million, in 1991, says Bakst. Donald Ryan at the research and consulting firm of CAP International in Marshfield, Mass., expects sales of 225,000 units in 1991.

"There's still a lot of room left in the market because it's still application-driven. If someone needs a PC fax board to do something, then price is not their main criteria," says Port at Panasonic. "It will be another year before all the people who need them have them."

Thereafter, three forces are expected to continue driving demand: cheaper prices, more applications and the growth of the regular fax market.

Prices today remain about where they were when the market was born, but George Mount, product manager for PC fax boards at GammaLink Inc. in Palo Alto, Calif., expects prices to drop 25% to 30% over the next year, as a result of expected price reductions in fax modems from Rockwell International Corp., which practically has a monopoly on that market. The modem, adds Mount, is 80% of the manufacturer's hardware cost.

That was a surprise to Dori Braun, fax modem product manager at Rockwell in Newport Beach, Calif. He says that Rockwell's modem sells at a 1,000-unit price of $90 for the 3-chip R96F and $100 for the 2-chip R96MD. No future price reductions have been announced, although Braun adds that prices have fallen by a factor of four or five since the R96F

came out in 1985 (replacing a 3-board modem). He also adds that Rockwell is working on a single-chip fax modem. Growth of the market may also allow PC fax board makers to enjoy larger quantity discounts, he says.

Rockwell also does not expect to see significant competition soon, Braun says. "This is not a simple technology — there is black magic in combining digital and analog."

As for applications, "In the next year we expect it to become a more feature-intensive market," says Port at Panasonic. "People will be adding Hayes modems, scanner interfaces, and encryption circuits to the fax board. The additional features will keep the price at the original level, while prices for the first generation of boards will drop a couple of hundred dollars." He expects the market to double every year for the next three years.

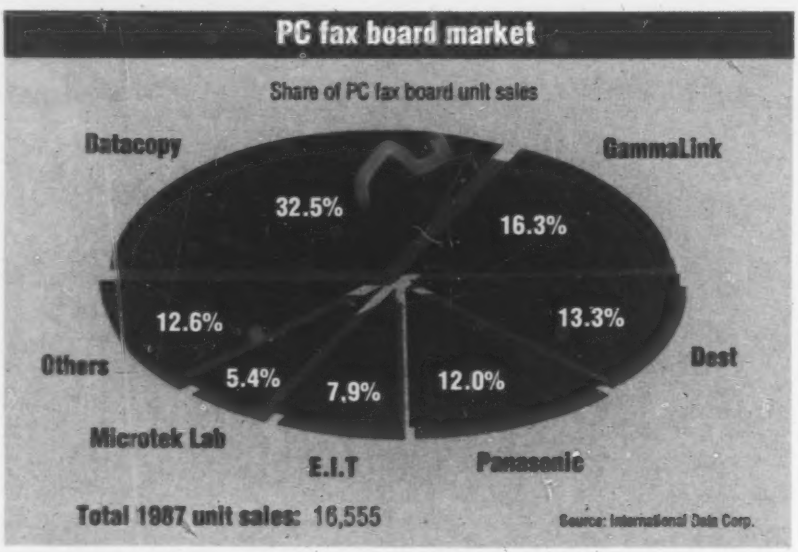
Ken Camarro, president of Camarro Research in Fairfield, Conn., estimates that 187,000 fax machines were sold in 1986, 450,000 in 1987, and that up to 800,000 will be sold this year. About 75% of the 1988 sales will be in the under-$2,000 range, predicts Camarro.

But anybody interested in the PC fax board market might want to heed the words of GammaLink's Mount.

"It took me a year to figure out that these were not replacements for fax machines," he says. "The user has to be PC-literate, and you need a fast laser printer, a fast scanner and a fast CPU before you have the equivalent of a fax machine," Mount adds.

"If you have time sensitive documents being produced on a PC and sent to a fax machine, then you have a potential use for these boards. Otherwise, buy a fax machine. These boards are probably doing more to sell fax machines than anything else that's come along," Mount says.

Lamont Wood is a Texas-based business writer



Six players divvy up the lion's share of the PC fax board market

Rigid-drive media makers spur production spending

Makers of thin-film disks are spending big to keep up with disk-drive firms' demands. The trick is in how big to spend, which calls for smart forecasting

BY ANDREA COHEN

For years, disk drive makers got by with disks coated with a magnetic oxide layer. But the emergence of thin-film technology, whereby disks have coatings of a much higher magnetic density sputtered or plated on, has the drive makers crying out for thin-film disks. As a result, the manufacturers of thin-film media are finding that the main question regarding production is not necessarily how much, but rather, how fast?

Currently, many manufacturers, such as Komag Inc., based in Milpitas, Calif., are running production lines 24 hours a day, seven days a week. Komag now has four sputtering lines in operation and, according to Hunt Payne, vice president for marketing, the company expects to have three more lines installed and operational later this year. Lin Data Corp., in Santa Clara, Calif., another manufacturer of sputtered media, has four lines that together make 200,000 disks monthly, with an additional one coming on line this month.

The media makers' capital investment surge does not come cheap. A fully equipped sputtering machine runs about $3 million and the price tag for a full production line hovers around $8.5 million. "We're absorbing capital investments at a pretty high rate — something around $3 million to $4 million a quarter," claims Terry Wood, sales and marketing vice president of Milpitas, California-based Domain Technology Inc., which is producing about 85,000 disks per week.

Komag's Payne adds that whereas a few years back most people thought that an investment of two to three years and $10 million to $12 million was sufficient to start a thin-film media company, in reality, the figures turned out to be more like $20 million to $25 million and four to five years. Komag will spend better than $25 million on capital investment in 1988 alone.

Peter Gove, general manager for marketing at Peripheral Components International (PCI), the recording head and disk vendor for, and subsidiary of, Control Data Corp., allows that PCI has already invested $10 million in its thin-film projects. He adds that providing heads or disks for leading-edge drive programs entails yearly expenditures of "several million dollars, just to stay current."

In such a capital-intensive market — and when the disk drive industry is almost as capricious as the semiconductor business — it's crucial for these media manufacturers to have accurate forecasts of market demand. If a thin-film maker forecasts accurately, it uses its money well. If a manufacturer puts in more capacity than is needed, it is risking a big overhang of investment which won't pay off for a long time.

Ouji-board forecasts

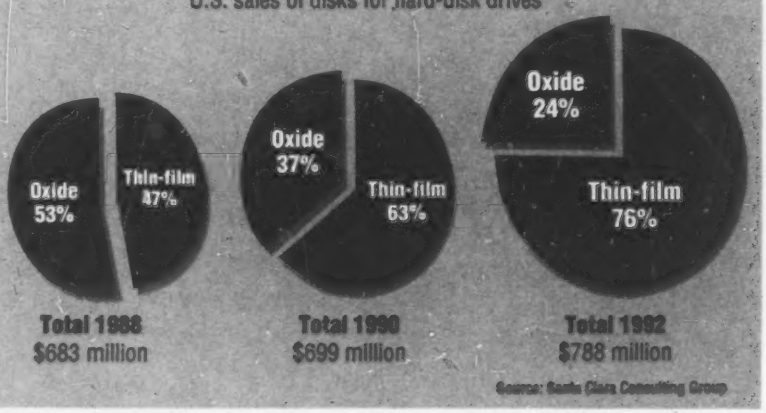
James Porter, president of Los Altos, Calif., market research firm Disk/Trend Inc., jokes that these companies anticipate demand "with a Ouji board." He explains that the makers of thin-film media are getting very large estimates from the drive manufacturers, who are still canvassing their own customers. "So [the disk makers] don't dare make the quantities suggested to them in total by the drive manufacturers. So they have to [trim back] a bit in their own judgement call — as to how much of those requirements they're being told about are real."

In line with that, Domain's Wood explains that his company figures market demand by exploring at least two levels of production, looking both at projections from customers and from customers' customers. Right now, however, Wood says that high demand means that Domain can pretty much "pick and choose targets."

According to Tazz Pettebone, senior vice president of Akashic Memo-

Thin-film vs. oxide hard-disk drive media

U.S. sales of disks for hard-disk drives



Source: Santa Clara Consulting Group

ries Corp. of Santa Clara, sales-growth projection has been easy: "For the past two years, there's been a higher demand for our product than we've been able to keep up with, even though we've continued to grow." However, Akashic has surveyed its customers to chart their needs through 1989. The company currently runs three sputtering lines, with two more on order for later this year.

Risky business

The industry "has swung more rapidly toward thin film than anybody thought," says Porter. Yet, although demand is unquestionable, the analyst points out that producing thin-film disks is still a risky business. "At one point," Porter says, "there were probably 40 or 50 thin-film media companies planning production or actually in production." Now the market has shrunk back to a small number of companies producing 2 million to 4 million disks a year, and a few other companies still "far back in the pack," producing 100,000 to 200,000 disks a year. Porter questions whether the latter will be able to get enough market share to produce enough disks and bring costs down enough to stay afloat.

Gary Davis, sales manager for Eikon Inc., in Simi Valley, Calif., the only privately owned volume player, agrees. This manufacturer of plated disks is currently running at near-capacity, producing 50,000 disks a month. "It's a major, major roll of the dice to be in this business because on the one hand you're dealing with a product that's extremely difficult to build from a technical standpoint, and has to be built in Class 100 clean rooms. . . . On the other hand, it's a product which, for marketing reasons, must behave like a commodity. Therefore, yields and volume must follow technology."

Davis anticipates the thin-film market to grow at an average compound annual rate of 68% through 1990. A February 1988 report from the Santa Clara Consulting Group (SCCG), a market research firm based in Santa Clara, predicts the U.S. thin-film market will grow from 13.5 million units in 1987 to 21 million units in 1988, with 1992 figures reaching around 48 million units. In revenue, that means a jump from roughly $240 million in 1987 to $320 million in 1988, and all the way up to $540 million by 1992.

Thin-film media makers, such as Komag, must plan on spending around $8.5 million for a full production line

But where, exactly, are all these disks going? According to Disk/Trend's Porter, high demand is the result of two factors. First, thin-film disks are replacing oxide disks. Secondly, thin-film media are being used on newer drives that are being pulled through by rapid growth in the personal computer market and in technical workstations.

High-end, high-performance 5.25-inch drives are heavily used in the 380MB class of products and in replacing older drives in minicomputers. And 3.5-inch drives "are growing like topsy," says Porter, "because the PC industry is now going to 3.5-inch drives — Apple, all the Japanese companies, Hewlett-Packard, and finally in this last year, IBM." Practically every 3.5-inch drive, except IBM's 20MB drives built in Fujisawa, uses thin-film disks. Porter believes that when IBM introduces its higher capacity 3.5-inch disk drive later this year, it will incorporate sputtered thin-film media.

The Japanese have invested substantially in thin-film media

Demand for the mini-drives will see media maker Akashic, whose production for the past year and a half has been dedicated to 5.25-inch disks, entering the 3.5-inch market by midyear. However, some participants believe that demand for 5.25-inch thin-film disks will remain strong, accounting for two-thirds of demand through the end of 1988.

Shortages or no?

There's some question over whether the demand rush will mean shortages of thin-film product. San Jose-based Maxtor, which uses thin-film disks in all its high-capacity, high-performance 5.25-inch drives, is getting all the disks it needs, according to vice president for operations, Steven Kitrosser.

However, Akashic's Pettebone warns that with the rapid conversion of newer products to thin-film media, "it would appear as if there would be a total shortage of supply" later this year or in the early part of next year. "The migration from oxide to thin film is just horrendous," he exclaims.

Shortages ought to mean higher prices. Yet Mark Geenen, associate director with SCCG, foresees strong price erosion. Currently, some thin-film manufacturers are selling lower end disks in the $10 to $12 range. Three and one-half inch disks in the 150MB to 170MB arena go from around $17 apiece up to $23. Higher end disks are currently priced at around $30 and should see a significant price decline this year.

Not to be overlooked are the Japanese, who have put hundreds of millions of dollars into thin-film media and whose installed capacity, according to Geenen, is "very large." He says that although the Japanese had grandiose plans about shipping a lot of media into the United States, they became very uncompetitive from a price standpoint when the dollar nose dived.

However, several Japanese companies, such as Fuji Electric, Mitsubishi Electric Corp. and Seiko Epson Corp. are now opening U.S. sales offices. Although U.S. firms currently have a lock on the thin-film business, Geenen foresees a limited number of contracts signed this year between Japanese media suppliers and U.S. drive manufacturers. □

Compatible makers push 3480 tape drives downward

Compatible tape drive makers are giving IBM competition in the high end. Now they may migrate 3480s to the midrange

BY BRIAN DEAGON

One of the great computer mysteries of the past decade has been IBM's direction in the high-end tape storage market.

As the harbinger of most computer standards, IBM launched the tape storage industry in new directions in 1971 with the introduction of the Model 3420 family of reel-to-reel tape drives, but then left manufacturers in a lurch for 12 years.

Not until IBM resurfaced in 1984 with the Model 3480 Magnetic Tape Subsystem has high-end tape drive technology evolved significantly. Several other nonstandard alternatives have been laid on the vendor's table but few have come to feast on the offerings.

Once introduced, the 3480 became an overnight standard. Computer industry vendors and integrators have embraced the 3480 technology and plan to make it their standard platform for offloading and storing large volumes of data from mainframes and networked minicomputers, industry watchers agree.

"Our customers like the 3480 solution," says Fred Hanhauser, Unisys Corp. program manager for tape and optical devices. Unisys has been shipping 3480-compatible systems since December. "The device has been stable and performed well in labs," he says.

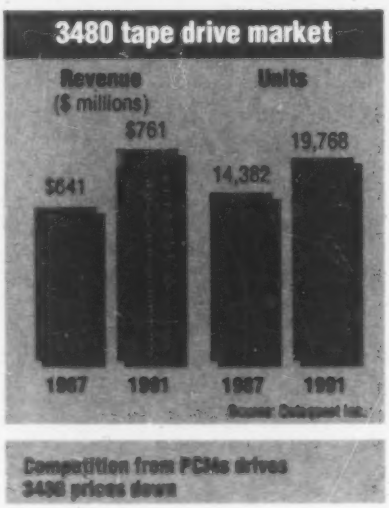
Digital Equipment Corp. is also evaluating 3480 technology and will likely adopt it this year, several analysts report. Other candidates studying the technology include Data General Corp., Hewlett-Packard Co. and Wang Laboratories Inc., observers say.

A 3480-compatible version will also be remarketed by European mainframe vendor International Computers Ltd. and by Comparex, a European joint venture between BASF AG and Siemens AG. The technology is also in use in Japan by Fujitsu Ltd. and Hitachi Ltd., which make their own 3480 versions.

"We'll see all the top 1,000 data centers convert to the 3480 technology by the end of 1989," predicts Joe Phillips, 3M Co.'s business development manager for computer tape products. 3M annually polls about 400 data centers nationally, Phillips says.

EMC Corp., Hopkinton, Mass., a systems integrator, will also sell 3480 or compatible versions into the DEC, Hewlett-Packard, Prime Computer Inc. and Wang marketplace. "We see the whole high-end minicomputer market going for the 3480," says Michael Egan, EMC's vice president of new product development.

The market for 3480 tape drives grew an estimated 20% to $641 million in 1987, from $535 million in 1986. By 1991, the market for IBM and compatible 3480 tape drives will grow to $761 million, a compound annual growth rate of 7.3% over six years, projects Dataquest Inc., a San Jose-based market research firm. The 3480 will displace about 70% of the high-end reel-to-reel tape drives in use today by 1991, industry watchers speculate.



"The mainframe computer vendors are definitely going for the 3480 and compatible format," says Louise Biggs, Dataquest senior industry analyst. "We believe the technology will also come down into the high end of the minicomputer market as well."

Total shipments of 3480 and compatible tape drives will grow to about 19,768 in 1991, up from 14,382 in 1987, says Biggs. A typical 3480, consisting of one 3480 tape controller and a tape unit which supports two tape drives, costs about $100,000.

The dinosaur and buggy whip

The 3480 introduction came none too soon for IBM. While IBM rested on its laurels with the 3420, several companies took significant market share away from IBM by improving on the basic reel-to-reel technology. One benefactor was Storage Technology Corp., which captured more than half of the high-end tape storage business from IBM during the interim.

IBM's foot dragging in tape storage technology was due to its penchant for hard disk storage technology, principally the Model 3380. IBM reasoned that users would prefer the benefits of on-line information stored on fast hard disk drives, compared with slower and more cumbersome tape storage devices. That fueled predictions that 0.5-inch reel tape drives would go the way of the dinosaur and buggy whip. In the meantime, tape processing flourished and worked its way down to the microcomputer.

Although shipments of high-end reel-to-reel drives are on the decline,

the concept of storing data on tape is firmly entrenched among major data-processing centers worldwide. With the growing acceptance of the 3480, 0.5-inch tape as a storage medium will remain an industry standard into the year 2000, notes Raymond Freeman Jr., president, Freeman Associates Inc., a Santa Barbara, California-based market research organization.

The 3480, when compared with the 3420, was evolutionary for several reasons. It reduced floor space and power needs by about 60% and cut by more than half the amount of time it took to transfer data on and off a system. The 3480 is also revolutionary, in that IBM tossed out the notion of using cumbersome 10.5-inch tape reels and instead christened the 3480 tape cartridge. The cartridge encloses the 0.5-inch media in a hard plastic shell that easily fits in the palm of a hand. One IBM cartridge can hold 200 megabytes of data, compared to 165MB on reel tape, which contains an extra 1,800 feet of tape.

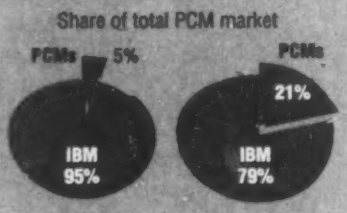
The IBM 3480 will recapture much of the market share IBM lost to competition in the high-end tape storage business. For one, the technology has been so difficult to duplicate that manufacturers intent on building plug-compatible 3480 tape systems have taken three years and spent upward of $25 million each getting their products to market. During that three-year window of opportunity, IBM has shipped more than $1.5 billion worth of 3480 products since 1984, according to market estimates.

3480 compatible makers

Four companies began shipping plug-compatible 3480 systems in volume this year and hope to give IBM a run for its money. These vendors expect to see good growth in 1988, as more and more data-processing centers begin to replace an aging fleet of 3420 and compatible drives. They are: Aspen Peripherals Corp., Longmont, Colo.; Fujitsu America Ltd., San Jose, Calif.; Hitachi America Ltd., San Bruno, Calif.; and Storage Technology Corp., Louisville, Ky. All four make OEM versions of the drive and all but Aspen also market the systems to end users.

Fujitsu and Hitachi market their drives through Memorex Telex and National Advanced Systems Group, respectively. Also, StorageTek has launched its end-user version, called the 4980, and recently clinched an OEM deal to supply International Computers, based in Britain.

IBM vs. PCMs in 3480 market



PCMs will capture 21% of the 3480 tape drive market by 1991

The 3480 plug-compatible manufacturers intend to compete against IBM in several ways. They hope to offer drives about 5% to 15% below the price of an IBM system, higher reliability, better service contracts and trade-in terms, and a better performing product. For example, Hitachi sells a version with a unique data compression device that can store upward of 500MB on a single cartridge, compared to IBM's 200MB cartridge.

Dataquest projects that these plug-compatible manufacturers will capture 11% of the 3480 market this year and 22% by 1991. Those projections could be altered once IBM introduces an improved version of the 3480 at some future point, acknowledges William Reedy, IBM manager for storage support marketing.

"The success of other vendors will bring more attention to the market"
William Reedy, IBM

"The competition is a mixed blessing," says Reedy. Although the competition presents a tough challenge to IBM, it nonetheless knights the technology as a de facto industry standard. "Our biggest problem was developing inertia. The success of other vendors will bring more attention to the market," Reedy says.

A market shakeout of sorts could occur in the future, however. Analysts caution that there is little room left for another major player at this time. In addition, there is a critical oversupply of 3480 cartridges, which indicates that vendors are currently satiated, notes Freeman of Freeman Associates.

Midrange fueling demand

Several factors are projected to fuel future demand of 3480 systems. One is the establishment of an industry standard interface beyond the IBM standard, such as SCSI or IPI III, which would speed up integration, observers say. Another development to watch is the anticipated introduction of a midrange tape storage solution that would also use the 3480 cartridge.

The 3480 design is so sophisticated that building a midrange system that would be able to exchange data with the high-end 3480 is an extremely difficult task. Cipher Data Products Inc. of San Diego has been developing such a product for IBM for more than 44 months. The delayed introduction of the IBM/Cipher product family has emerged as the new mystery in tape technology.

However, IBM recently gave Cipher the go-ahead to introduce its version of the products, with no indication whatsoever if Cipher's product will emerge as an acceptable midrange solution, or be compatible with anything IBM might later introduce.

"It's becoming more and more important to be able to transfer data from the low end to the high end," notes Dennis Alessio, eastern regional sales manager for Hitachi America.

"The lack of a midrange solution could be a serious problem," acknowledges Jay Bretzman, an industry analyst for International Data Corp., a market research firm.

This lack of a midrange 3480 solution is a key reason why leading suppliers of 0.5-inch reel-to-reel tape drives say business is good. But despite what IBM might do in the mid- and low-end tape storage arena, it has a sure winner with the 3480 at the high end, industry watchers acknowledge, and the compatible hyenas are sitting at the table to feast. □

High-speed modem madness: In search of standards

Data compression, a technique which can double or triple a modem's speed, is changing the face of the 9,600 bps segment

BY GEOFFREY L. SMITH

Personal computer companies have spent millions in research dollars meeting the challenge of higher speeds at cheaper prices. But for modem manufacturers that provide the links among PCs over public phone lines, the real challenge involves standardization.

Currently, the modem market is plagued with a lack of standards, especially in the fledgling market for high-speed dial-up modems — those that transmit at 9,600 bits per second (bps) and faster — resulting in confusion for customers, and a slow start for a promising market.

And recently, a technology has emerged that may make things even worse. Data compression, which can double or triple a modem's speed when used to transmit certain kinds of data, is now appearing on slower, less expensive modems, making them competitive with the 9,600 bps modems. The technique involves identifying repetitive patterns — such as zeros in a spreadsheet — so they can be encoded into a smaller number of characters. Some companies incorporate data compression into the chips in their modems while others sell add-on units.

Talk to me

James Jordan, president of Telebit Corp. in Cupertino, Calif., one of dozens of companies in the 3-year-old, 9,600 bps dial-up market, calls the market "a mess" because of the huge disparity in technology used to make 9,600 bps modems. "From a user's standpoint, it's very confused," he says. "None of the manufacturers make modems that talk to one another. There are no standards. It's an area where standards are needed very badly."

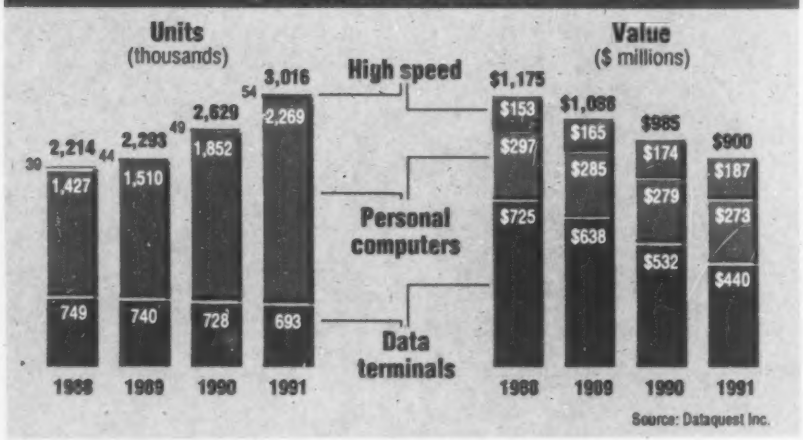
When the 9,600 bps dial-up market got started in 1986, two companies dominated the market. Telebit Corp. and MicroCom Inc. were pulling in most of the market's $20 million in sales, according to Dataquest analyst Larry Cynar. But even after about a dozen others entered the field last year, the market only grew to about $30 million, Cynar says. Below the 9,600 level, a low-end 1,200 bps segment is firmly in place. In that segment, Hayes Microcomputer Products Inc. in Atlanta has created a de facto standard. But to date, says Cynar, no market leader has emerged to drive the high end.

Hayes makes a $1,200, 9,600 bps modem as part of its V series, but it uses proprietary technology that prevents it from communicating with modems from other manufacturers. Meanwhile, other manufacturers offer the V.32 standard, recommended by the Consultative Committee for International Telegraphy and Telephony (CCITT), for transmitting data at high speeds over public telephone lines. However, Dennis Hayes, chairman of Hayes Microcomputer, says his modem costs half as much to make as a modem that complies with the V.32 standard, and still performs as well.

While he sympathizes with customers faced with a confusing array of choices, Hayes thinks they are better off than they were last year. "We have more options for the user. . . . The nature of datacommunications is getting more complex. I don't think that means it's getting worse for the consumer," he says.

Still, with dozens of 9,600 bps modems on the market, few of which are entirely compatible, not all modem makers are going to survive. With so much competition, "there's going to be a shakeout in the high-speed dial-up modem market," predicts Telebit's Jordan. A key issue that will determine the fate of the sur-

U.S. modem market

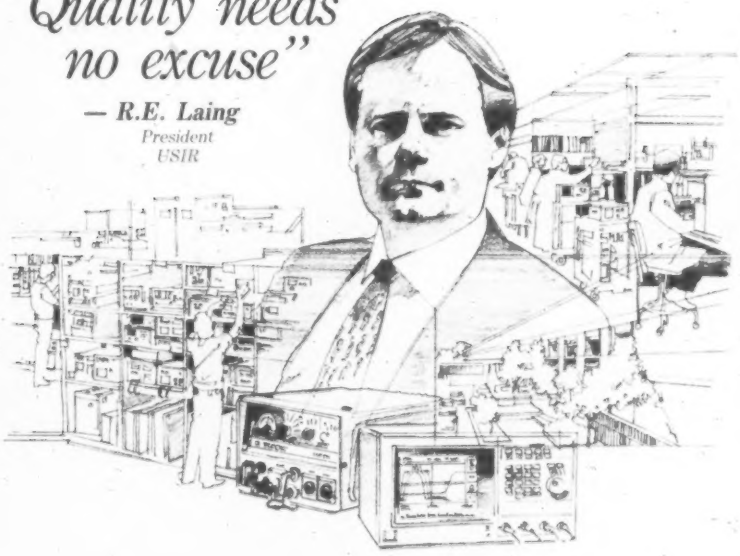


Source: Dataquest Inc.

Growing use of modems with personal computers will drive unit sales of modems up, but rapidly falling prices will cut back the dollar value of the market

"Quality needs no excuse"

— R.E. Laing
President
USIR



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vivors is whether the V.32 standard is selected by CCITT. But other issues are more complex.

Some manufacturers have started adding data compression technology to their 2,400 bps modems, kicking up their speed by a factor of two or three while only adding about $100 to the cost. Cynar thinks this may bring problems for 9,600 bps modem makers. A 2,400 bps modem equipped with data compression technology that increases transmission speed three times, to 7,200 bps, is nearly as fast as a 9,600 modem, and less expensive, he says.

MicroCom Inc., for example, has a standard it's pushing, called the MicroCom Network Protocol; Hayes has another data compression technology; and still others are coming on the market. Recently, Adaptive Computer Technologies developed a new faster data compression technology that has received support from a number of modem vendors, according to Cynar of Dataquest. "The market is messy, but it might have gotten even messier now because we have data compression issues," Cynar says.

With dozens of 9,600 bps modems on the market, not all makers are going to survive

Both Hayes and Jordan point out that the same data compression technology can be used on both 2,400 bps modems and 9,600 bps modems —a fact they think mitigates the potential influence data compression schemes may have on their own markets.

Adds C. Kenneth Miller, chairman of Concord Data Systems in Marlborough, Mass.: "I don't see it [data compression] eating into V.32 at all because it makes V.32 run better." Miller believes 9,600 bps modems using the V.32 standard will soon dominate the market because the price of those modems is coming down quickly. "The nonstandard products will end up dying," he says.

"There are still a lot of people buying their first modem out there," comments Cynar. "I think the world is headed toward V.32 . . . but we're not moving too quickly into it." □

IC equipment vendors wise up to economic reality

They must: There are still far too many of them, and IC makers are pruning supplier lists. So the gear firms are going back to what they do best

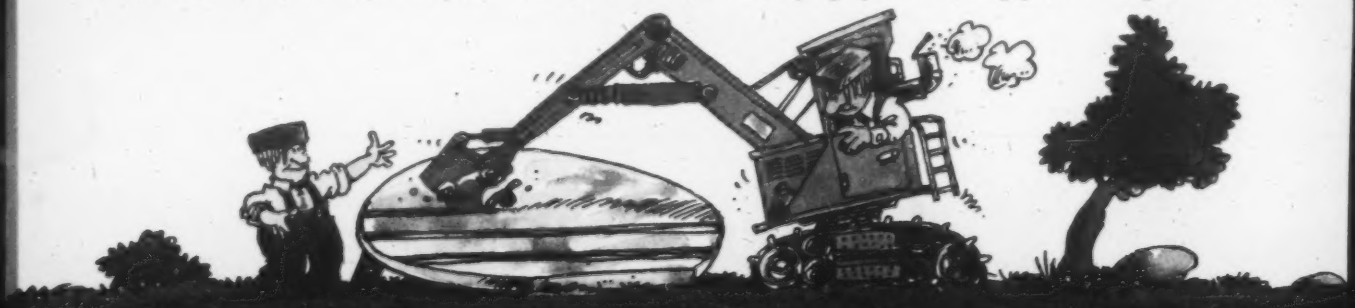
BY MARK MEHLER

After suffering through two years of declining sales and persistent calls from their customers to straighten out their act, suppliers of semiconductor-production equipment — for both front-end processes and back-end assembly — are wising up to a changing industry.

Broad-line vendors, who had overextended themselves in a bid to become virtual one-stop shops, have pared down their operations to concentrate on their mainstream businesses. Decentralization — the watchword of the IC equipment industry, until it got out of hand —has been replaced by an emphasis on consolidation. In short, say observers, the industry is undergoing a painful, but necessary, structural change.

"A number of things have happened," explains Joseph Grenier, a senior industry analyst at San Jose-based research firm Dataquest Inc. "First, the costs of developing systems and supporting and servicing them have grown so large that even the biggest players can't afford to do it all anymore. Second, the amount of investment in equipment is now so huge that capital equipment committees are not willing to go with any supplier that isn't financially secure enough to ensure long-term survival. The major buying criterion today is no longer technology; it's the ability to support your systems in the field."

The pruning of supplier lists that is taking place throughout the elec-



Total worldwide shipments

($ billions)

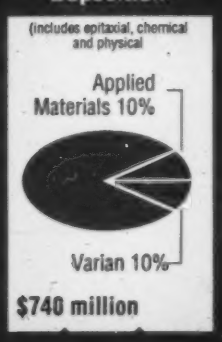
Equipment	1987	1988
Wafer fabrication	$2.71	$3.40
Test and inspection	2.37	2.93
Assembly	0.66	0.78
Total	**$5.74**	**$7.11**

Equipment

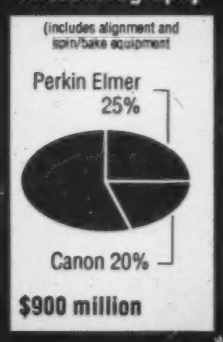
Estimated 1987 worldwide sales
(Worldwide sales are for fiscal 1987)

Semiconductor fabrication

Deposition



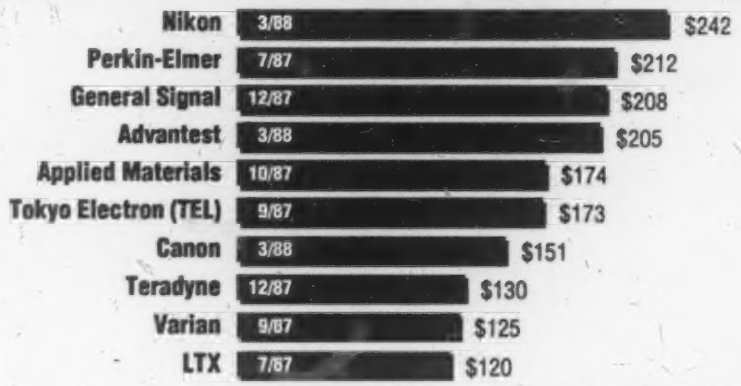
Microlithography



Dry etching

Top semiconductor production equipment makers

Worldwide fiscal year sales ($ millions)



Source: VLSI Research Inc.

tronics industry is occurring with a vengeance in IC equipment. Glen Possley, who heads the die-manufacturing organization at Signetics Corp., says his company no longer wants to deal with multiple vendors of the same equipment. In etching systems, for example, Signetics has narrowed its supplier list to two: Applied Materials Inc., and Lam Research.

"We won't install a piece of prototype equipment in a fab," argues Possley. "We will only buy a proven system from a proven supplier."

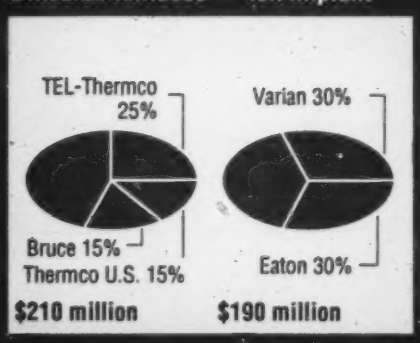
The raw numbers, says analyst Stephen Balog of Shearson Lehman Hutton Inc., simply don't add up. "There are just too many players," he contends. "In etch, figuring in huge sales support overhead and engineering costs of $5 million or $10 million for a new system, you have to be able to produce these [machines] in volume to amortize the cost . . . the industry can't afford 30 or 40 etch suppliers."

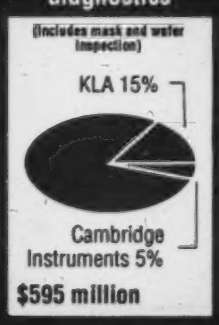
Some examples of how the equipment industry has responded to these realities: Perkin-Elmer Corp., the leading worldwide systems supplier for seven years, before falling to the No. 2 position in 1987, behind Nikon Precision (see accompanying chart), pulled out of its dormant etching and sputtering businesses last year to concentrate strictly on its successful optical and electron-beam lithography operations; General Signal Corp., the No. 3 supplier, has consolidated about 20 different autonomous companies into six divisions, and exited at least three market segments, including photomasks; Varian Associates, the ninth largest supplier, backed out of the etch business; and GCA Corp., which was the leading maker of wafer steppers in the early 1980s until running adrift financially, agreed to merge into General Signal last March.

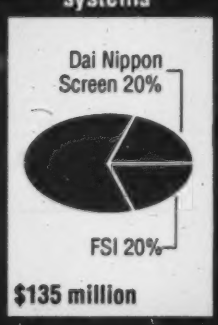
"Life was a lot easier in the 1970s

Jon McIntosh

Major equipment markets and leaders







and early 1980s," sighs David Huchital, vice president of Perkin-Elmer's Connecticut operations, which include optical lithography systems. "Our highly segmented approach to the market was the proper response to serving the individual markets. Now it's a much tougher world out there. We're not going to see another boom year like 1984. Our customers have made enormous strides in increasing utilization of their existing equipment, and we're being hard-pressed on issues like set-up time."

Moving people around

Under PE's new functionally and geographically based organization, Huchital manages the company's analytical instrument business and other Connecticut operations, in addition to lithography. He says this allows the flexibility to shift resources according to market demands. Right now, for example, the instrument business is hot, while the government business is not. "If that changes, I can move people around without having to resort to layoffs," says Huchital. "The corporate goal, which is greater flexibility and quicker response, fits perfectly into the requirements of doing business [in the IC equipment industry]." PE last year posted about $212 million in IC equipment sales, about two-thirds of its revenue in 1985, according to research firm VLSI Research Inc.

Pruning of supplier lists is occurring with a vengeance

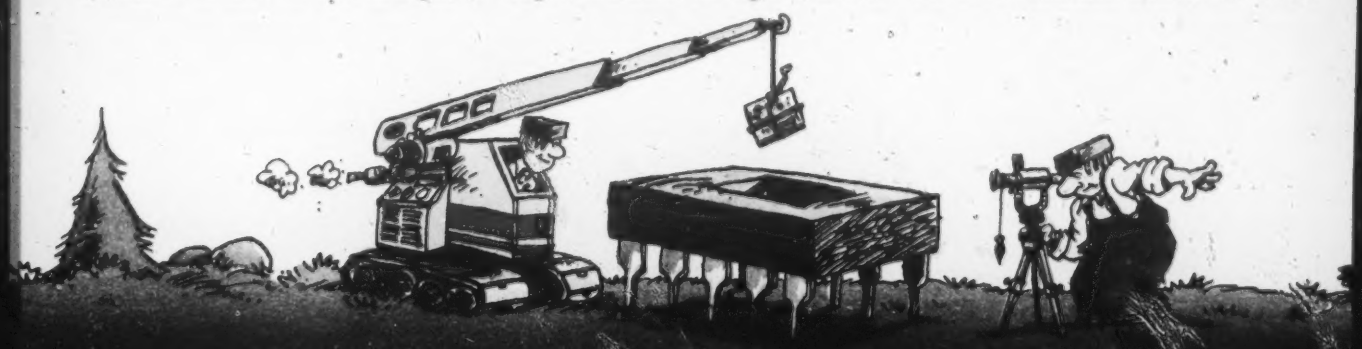
Jack Halter, senior vice president for operations of General Signal's Technology Industries Sector, which includes semiconductor equipment, explains his company's recent consolidation as an effort to become the No. 1 or No. 2 player in each of its target markets. Halter agrees that the days of the marginal vendor — as anything other than the so-called "walking dead" — are numbered. He adds that the acquisition of GCA, which augments the company's existing Ultratech Stepper business, should catapult GS into a leadership role in both direct image, called 1:1; and image reduction, such as 5:1 and 10:1; steppers.

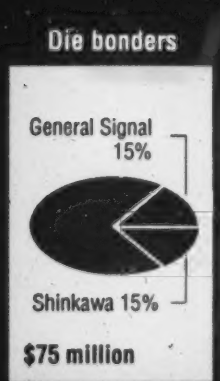
Breaking even

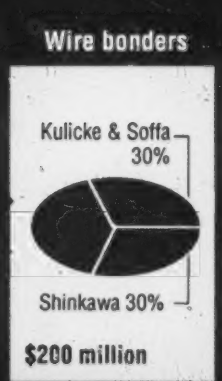
Nevertheless, even for those suppliers that already hold leadership positions in more than one market, profitability is not assured. Applied Materials Inc., which is the leading supplier of etching, chemical-vapor deposition and epitaxial reactor equipment, only broke even last year after losing money in two quarters, notes chairman James Morgan. Morgan attributes the disappointing earnings to the expense of rushing the newest CVD system to market.

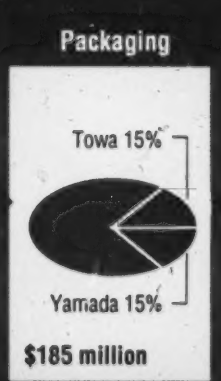
As for the industry's near-term outlook, VLSI Research's president G. Daniel Hutcheson sees worldwide

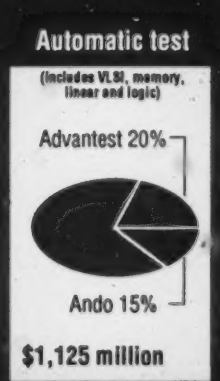
Jon McIntosh

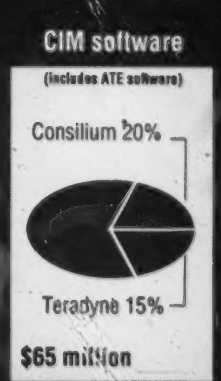












shipments rising for the second straight year. After sliding to $5.03 billion in 1986, shipments rose to $5.7 billion last year and will reach $7.1 billion this year, says Hutcheson. The researcher attributes most of that expected growth to skyrocketing demand from Japan for new DRAM capacity, and to rising sales in Europe, Korea and other foreign markets. In Taiwan alone, he says, 13 IC companies have started up in the past year.

U.S. merchant IC makers, however, remain "afraid" of another recession next year, says Hutcheson. Should they begin loosening their purse strings, he believes, "our projections will go through the roof."

Signetics' Possley, in fact, already sees U.S. chip makers getting serious about bringing on new fabs over the next two years. He says Signetics will spend $100 million on capital equipment this year, more than twice as much as it spent in 1987. "I see people like Texas Instruments and Motorola anxious to bring on new capacity," he says. □

Semiconductor materials market

Worldwide market ($ millions)

Semiconductor fabrication materials	1987	1988	1989
Silicon and other substrates	$1,380	$1,789	$2,039
Photomasks	885	995	1,134
Resists, Positive	103	125	142
Negative	71	86	98
Advanced	5	6	7
Wet chemicals	258	379	431
Gases	467	519	591
Deposition materials	173	203	231
Total fab materials	**$3,342**	**$4,102**	**$4,673**
Semiconductor packaging materials	**1987**	**1988**	**1989**
Leadframes	$728	$970	$1,077
Ceramic packages, metalized	499	665	742
Encapsulation resins	309	412	493
Cerdip	288	384	389
Headers, cans and lids	186	290	320
Thick film pastes	206	220	242
Multichip substrates and packages	174	215	237
Die attach materials, bonding wire	300	384	445
Other materials	146	175	210
Total packaging materials	**$2,636**	**$3,715**	**$4,155**
Total semiconductor materials	**$6,178**	**$7,817**	**$8,828**

Source: Rose Associates

Chip-making software: Still waiting for the big time

Back in 1984, few businesses looked as promising as the emerging market for software packages to run semiconductor fabrication plants. Every major integrated circuit supplier had automation on the brain, and such software functions as controlling the flow of work-in-process and scheduling equipment maintenance were seen as crucial to that effort. Then, in 1985, the IC industry turned down, and continued down for two years.

"It goes almost without saying that in a deep recession like the last one, the first thing to go is the automation plan," says Peggy Marie Wood, who follows the manufacturing software sector for market researcher Dataquest Inc. "Everyone agrees that what the [software houses] offer is marvelous, and absolutely essential to automating a fab, but very few customers can justify a long-term investment when the bigger issue is survival."

The current size of the market is difficult to determine, however, as the industry tends to report sales by installation. Some IC facilities employ a range of software modules; others use only one or two. Analysts estimate 1987 U.S. industry volume at no more than $25 million, virtually all of it shared by two California-based companies: Consilium Inc. of Mountain View, and Promis Systems Inc. of Santa Clara. Consilium is believed to have a base of about 180 to 200 installations and Promis about 60 to 80 sites. Hewlett-Packard Co., which backed out of the market a few years ago in the belief that it would not support an expensive product development effort, continues to service its roughly 95 existing installations. Two newer players, Cameo Systems, which has picked up a few sites, and Qronos Technology Inc., which has yet to install its first commercial system, are trying to work their way into the market.

In the past 12 to 18 months, Consilium and Promis have moved aggressively to broaden their bases outside the IC market, selling software modules into the printed circuit board, aerospace and pharmaceutical industries. George Kellar, director of corporate development at Consilium, says diversification is a key to the company's strategy, but he insists its bedrock semiconductor-related business is alive and well. In addition to strong offshore sales, says Kellar, major U.S. customers are finally discovering that automation is no luxury.

Meanwhile, no matter what the current state of the market, the potential is vast. Maria Ligeti, the president of Qronos, which offers an IBM-based system featuring fault-tolerant transaction processing for quicker response time, points out that fewer than 25% of the world's IC plants have installed any commercial software package. "It's a huge empty market we're hoping to fill," says Ligeti, who believes that the market could reach $750 million by 1993.

The picture sharpens for U.S. cable equipment manufacturers

As the cable television industry penetrates more households, demand for converters and other gear intensifies

BY DEBBIE NARROD

Last year proved to be a banner year for cable television equipment suppliers — the best since the early '80s — and most manufacturers expect 1988 to be strong too, as cable system operators continue to upgrade and rebuild their systems.

Senior analyst Steve Rosenberg of Paul Kagan Associates (PKA), a research and investment firm in Carmel, Calif., believes, in fact, that 1988 will be one of its biggest years for construction ever. "There's no doubt [about it]," he says. "All the projects are in the pipeline."

He's projecting a $2.6 billion market for cable construction in 1988, up 12% to 13% from 1987's $2.3 billion. Those figures include not just electronics equipment, but also coaxial cable, labor and design. But it's obvious that the electronics segment also will be very strong.

John Donohue, president of Oak Communications Inc., says 5 million to 5.5 million "addressable" in-home TV set-top cable boxes, or converters, will be sold this year, about the same number as last year. "Addressable" units are cable signal descramblers that can be given messages — or addressed — from a cable operator's central computer to allow certain channels to be viewed, or scrambled, in the subscriber's home.

"Plain" converters, without fancy electronics and incapable of allowing a change in viewable channels without a visit from the cable company, will sell in the range of 4 million units in 1988, about even with '87, according to Oak's projections; and up from between 2.5 million and 3 million in 1985.

Driving the growth are several factors. The cable industry has been consolidating drastically in the past few years, with operators buying one another out at an incredible pace. "The new owners are driven by their cash flow projections to add services and increase cash flow," points out PKA's Rosenberg.

Eugene Mopsick

General Instrument's Krisbergh: "The trick is to make the customer perceive the converter as an added value, by offering pay-per-view"

Impulsive viewing

Addressable converters, especially those capable of what the industry calls impulse pay-per-view (IPPV) which allow a cable subscriber to punch in a few numbers on his box and then see a special show or movie, and be billed later, is one way to increase revenue.

Executives at American Television and Communications Corp. (ATC) in Denver, and Continental Cablevision Inc. of Boston — the No. 2 and No. 3 cable operators, respectively — estimated systems serving half of their subscribers were addressable-capable. Included in that number are also subscribers with the necessary computer equipment at the systems' headends. Headends are the individual system's headquarters facility, which receives TV and satellite signals; changes them to different fre-

quencies for cable distribution of signals; and begins the distribution process.

"We will roll out a substantial number of addressable PPV homes in 1988," says Continental vice president Rob Stengel, who adds that "virtually 100%" of Continental's operations — including those of soon-to-be-acquired American Cablesystems Corp. — are rebuilt and upgraded. "In a lot of those systems we will be going addressable."

Home shopping, which can also use the IPPV technology, is another growth area, and operators and manufacturers alike are expecting the day to come when banking and other transactional deals can be done through the cable converter box rather than outside the home.

Operators are also replacing distribution — TV signal carrying — electronics with newer models. ATC vice president for engineering and technology James Chiddix points out that the technology has advanced a great deal over the past three years. "The cables put in place five years ago carrying 30 channels can be pushed to 40 to 50 channels [with the new equipment]," he says.

Steven Necessary, Scientific-Atlanta Inc. (SA) marketing manager, broadband communications, says he believes that while cable operators are looking to spend the same in 1988 as they did in 1987, more of the money will go to distribution upgrades, using the newly developed amplifiers. Amplifiers are electronic devices used to increase the strength of a TV signal; they are placed along distribution cable often enough so that a good signal is maintained.

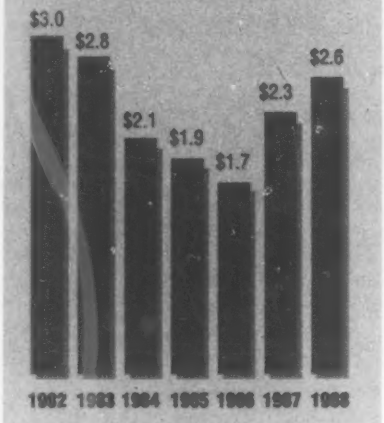
Some of the new amplifiers and equipment allow old cable that offered 30 channels of service to be upgraded, offering 35 or 40 more channels. This is called increasing the bandwidth of the cable, and a lot of operators are simply adding the new distribution equipment to do this, getting more subscriber money for more channels offered.

Addressing addressability

While the distribution equipment is new, addressable technology is not. Denver-based Tele-Communications Inc. (TCI), the nation's largest cable operator, went "extensively into addressability in 1983," according to Dave Willis, director of engineering.

Cable TV construction market

U.S. market for electronics equipment, coaxial cable, labor and design ($ billions)



Source: Paul Kagan Associates

The cable TV construction market is almost back to the level of the early '80s

But for addressability without IPPV capability, he notes, "there's diminishing demand as more customers take advantage of cable-ready TV sets."

Such sets were designed by TV manufacturers to eliminate the set-top converter box from the cable company, allowing the cable signals to feed into the TV — because of adequate large-channel capacity — straight from the coaxial cable. But addressable systems scramble or encrypt each signal so that, from the central facility, the cable company controls the headend, which signals what a customer receives. Customers with cable-ready sets in an area where the cable company has addressable equipment will have to have a converter box anyway.

The cable industry has been consolidating drastically in the past few years

"The trick is to make the customer perceive the converter as an added value, by offering pay-per-view," says Hal Krisbergh, vice president and general manager of the Hatboro, Pennsylvania-based Jerrold Division of General Instrument Corp. "It's a perspective issue."

"Pay-per-view (PPV) has been a promise, a gleam in the industry's eye for a number of years," says SA's Necessary, "and the quantity and quality of programming is finally to the point where the promise is being fulfilled."

General Instrument and SA are the leaders in cable equipment manufacturing, holding about 75% of the market, says Robert Anastasi, analyst with the Robinson Humphrey Company Inc. in Atlanta. GI, he says, has about 50% of the market and SA about a quarter.

GI uses a custom VLSI chip in its boxes, Krisbergh says, claiming a product that is "world class in terms of sophistication." He points out, however, that the converter box is only part of a system that depends on an intensive amount of hardware in the headend. The headend not only has equipment to move signals from satellite-transmitted frequencies to cable distribution frequencies, but also computers to handle addressable functions and control functions, allowing for changes in the channels a subscriber receives, as well as for billing those changes properly.

Historically, Krisbergh comments, the idea of a two-way transmission failed because of the complexity and cost of the set up, such as AT&T's videotex system, Viewtron. "The key is the memory space in the security system," Krisbergh says, to be able to store PPV information in the box and pull it out at a later time. "To store isn't complex," he says. "But to pull in information from 100,000 boxes is."

GI and others have developed affordable technology for this, of late, and at the same time program services have begun to make PPV offering movies and special events desirable. "There's why the industry is so excited," Krisbergh says.

General Instruments saw sales grow to $100 million in 1987, Krisbergh says, up 60% to 70% from 1986. The company is expecting about the same this year, a seeming flatness he says "belies the fact addressability is growing significantly," because last year's sales included a large movement of "plain" converters as operators restructured channel

offerings after a change in federal laws.

SA's Necessary wouldn't project what his firm is expecting for 1988. The company's first quarter report, for the period ending Oct. 2, 1987, says that new orders were up 21%, and analyst Anastasi says the report understates the company's strength.

Pioneer Communications of America Inc. shipped a record 850,000 converter boxes last year, according to marketing manager Mike Hayashi, and expects to move about the same number this year. Slightly more than half of last year's units were addressable.

Zenith Electronics Corp. saw cable business up 20% in 1987 over 1986 and expects to meet 1987's figures this year, according to Vito Brugliera, vice president for marketing and product planning. Zenith cable products. Brugliera cites a "renewed interest in addressable converters" as a reason for the growth, as well as for some new products. Some of the proprietary electronics in Zenith's equipment are made in-house and others are contracted with outside vendors.

Oak is hoping for a 20% increase in revenue this year over last, Donohue says. "The industry has been hot. Cable built 26% more miles of cable distribution in 1987 than in 1986," he points out.

"Substantially more activity is planned," he continues, pointing to the last of the new systems getting started, to consolidations requiring rebuilds as systems transfer hands, and to an improved market for home terminals.

An innovation on the horizon for cable TV is the use of fiber-optic cable

Oak's most sophisticated line is its Sigma addressable converter, the only box, Donohue says, that uses encrypted audio as part of its security.

"The industry is looking for features," Donohue comments. "They would like the box to go away, but that's impossible."

Instead, he says, the box must be friendly both to consumers and cable operators.

Trade groups National Cable Television Association and Electronics Industry Association have developed what they're calling the IS-15 or Multiport, to help solve the problem, notes NCTA vice president of science and technology, Wendall Bailey. The Multiport combines the tuner, power supply, remote and electric cord common to one's TV set, VCR and converter box. Placed in a TV set, it eliminates interface problems when a cable operator has compatible equipment. Pioneer is looking at using the IS-15, Hayashi says, and Bailey says RCA Corp. and Panasonic are among manufacturers using it in TV sets. None of those companies are manufacturing the equipment for the standard.

Because of the incompatibility between cable-ready TV sets and VCR addressable cable boxes, a number of manufacturers are offering what's called "off-premise" equipment — not electronic — that avoids the issue altogether because signals are trapped or untrapped outside the home. But pay-per-view is limited. TCI has put off-premise equipment in a few large systems, but TCI's Willis says it's possible TCI may eventually upgrade the box to addressability. "We'll keep the options open," he says. "We haven't yet seen a huge success in PPV, but it may be there, and if it is, we want to take advantage of it."

One more innovation on the horizon for cable is the use of fiber-optic cable, which to date has been costly and problematic. "There are deep technical problems in going totally analog," observes Willis. But operators are trying it. ATC is working on a system that would use existing coaxial cable in small pieces served by a fiber-optic backbone, says Chiddix. "The key is the breakthrough on cost and perfection of analog transmission." While some in the industry say the clearer signal offered by fiber-optics would reduce the number of amplifiers used by cable companies, Chiddix said the way ATC is looking at using fiber-optics, few electronics would be eliminated. □

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Singapore's plan to offer more than cheap assembly

Singapore now wants to attract more sophisticated development work. Deals with National and Sierra Semi are a good start

In the late 1960s, Singapore's economy was faltering. British investors were pulling up stakes as Singapore prepared for independence. Making matters worse, baby boomers hit the streets looking for jobs at a time when unemployment was running at about 20%. "We were hit with a double whammy," says Liow Voon Kheong, head of the Electronic Components Group of Singapore's Economic Development Board (EDB).

Singapore's government moved fast to attract foreign manufacturers. "Back then, we just wanted employment for our people," says the EDB head. U.S. firms quickly moved in. Fairchild Semiconductor Corp., National Semiconductor Corp. and Texas Instruments Inc., for example, set up shop and brought with them thousands of assembly-line jobs. "When you industrialize from scratch, you have to make use of foreign investment to grow," says Philip Yeo, EDB chairman, interviewed at the Board's Singapore office.

Singapore not only survived the transition from a British colony to an independent nation. It thrived and even overcame a serious recession from 1982 to 1985. Focusing on electronics, Singapore lured millions of dollars in foreign investment. As a result, unemployment today is less than 5%.

Now, says Yeo, Singapore is embarking on a new economic development strategy. No longer content with just attracting assembly-line jobs, the EDB is focusing on luring more sophisticated development work to the country. "We're in a much better position to attract more value-added manufacturing," says Yeo, who wants to expand research and development and engineering work in his country.

"Providing low-cost labor was only a short-term solution, according to Yeo. "There will always be countries that offer cheaper labor," he explains. The long-term winners, he continues, will be those countries that provide a solid infrastructure, efficient workers and flexible financing. And, Yeo stresses, Singapore intends to be a long-term winner.

Singapore swing: From British outpost to thriving economics powerhouse inside 30 years

Comstock, Inc.

Toward that end, Singapore Technology Corp. Ltd. (STC) — a diverse group of companies created with government investment — in November announced the formation of Chartered Semiconductor Ltd. Chartered Semiconductor, a joint venture of STC, Sierra Semiconductor Corp. and National Semiconductor, will fabricate and test state-of-the-art CMOS application-specific integrated circuits. Chartered Semiconductor will invest $40 million in the wafer fabrication plant and an additional unspecified amount more for equipment. "It's a coup for Singapore and a coup for us," says James Diller, Sierra president.

Owned 74% by STC; 17% by Sierra; and 9% by National, the joint venture will be the first operation in Singapore capable of designing and fabricating CMOS chips. Also planned is a design center where circuit designers will develop standard products and ASIC design services for Asia.

Three-tech trio

When Chartered Semiconductor's planned facility comes on stream early next year, production capacity will be 5,000 6-inch wafers per month, with the potential to double capacity in the future. Chartered Semiconductor, to be based in Singapore Science Park, is expected to generate about $50 million a year in sales. In the early stages, more than half of production will be sold to the three partners — a solid underpinning for the venture.

"This will be our major manufacturing facility," says Sierra's Diller. "Well over half our products will come from there in the forseeable future." Ed Pausa, National Semiconductor vice president for international manufacturing, says the joint venture will "satisfy a number of National's needs and interests," including expanded chip-making capacity without significant additional capital investment as well as access to improved process technology.

Production will be based on Sierra's Triple Technology CMOS process, which permits integration of three technologies: analog, digital and nonvolatile (electrically erasable) memory all on the same chip. National shares the technology, which both U.S. firms say is ideal for very large-scale integration chips applica-

WHEN THERE
WILL BE
NO LONELINESS,
NO DESTITUTION,
NO SICKNESS,
NO WAR,
ONLY THEN
WILL THERE
BE NO NEED
FOR THE
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ble for a wide variety of niche markets with high growth potential.

STC concurs. "Through our strategic partnering with Sierra and National — which provide advanced technology and market access — we are able to create a commercially viable semiconductor business," says Lim Ming Soong, STC deputy chairman. STC had been searching for new technologies to complement and strengthen its traditional defense and industrial electronics businesses. Yeo, who serves as chairman of STC as well as EDB, says the formation of Chartered Semiconductor is the latest in Singapore's continuing efforts "to position our country at the forefront of technology."

Yeo points out that Chartered Semiconductor will create new jobs for engineers and technicians. The firm is expected to employ 260 workers by the end of next year, 40% of which will be technical engineering personnel. "This is consistent with our continuing efforts to provide more and more highly skilled and sophisticated employment opportunities for Singaporeans," says Yeo. Meanwhile, some 55 Singapore engineers will be trained at Sierra and National's U.S. facilities this year.

Partner power

STC had been looking for an American partner for integrated circuits since 1985, when it hired a consultant to find an appropriate company. The consultant screened 15 relatively small firms, finally recommending Sierra — with the provision that a larger company with big buying power be brought in as a third partner and customer. National Semiconductor seemed a likely choice. Since Sierra's inception in early 1984, Sierra and National have had many technology agreements and business transactions. Furthermore, Sierra president Diller was National Semiconductor's managing director for Southeast Asia (based in Singapore) from 1973 to 1975. National has had a production facility in Singapore for almost 20 years. STC and Sierra, meanwhile, have had a close working relationship for the past two years. STC has invested in Sierra and served on its board of directors.

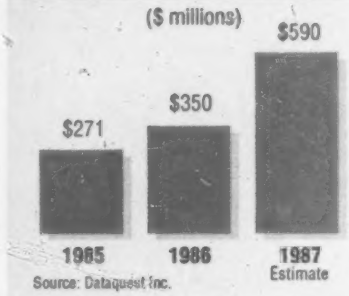
Chartered Semiconductor's production capacity will be 5,000 6-inch wafers per month

Donald Valentine, Sierra chairman and senior partner of Sequoia Capital, a Menlo Park, Calif., venture capital firm, helped arrange the deal. For several years, Valentine has been working with Singapore's economic officials to invest the country's money in high-technology ventures. "Singapore is interested in expanding its technology base to increasingly higher levels," he says. Chartered Semiconductor is an example of the government's desire to expand Singapore's technological base and acquire new markets as well. "The real thrust of EDB and the government is to do exactly what has been done with Chartered Semiconductor," says Valentine.

Though Singapore's political leaders have been known to keep tight reins on various enterprises, business partners give government agencies high marks for letting foreign firms run their business without interference. Government officials, for their part, contend that they try to keep out of publicly funded ventures — even if it's necessary to prop up a failing business. "Companies must live or die as commercial ventures," says Lim. "The government's interest is only as a shareholder."

BETH KARLIN

Singapore's semiconductor consumption



Source: Dataquest Inc.

Singapore's goal of becoming an R&D and engineering center means more local production of advanced chips — and more chip consumption

Computer companies are back to their growing ways

After a brief hiccup in 1986, computer production again outpaces all industry. Even without AI's help

Maybe the world is becoming a little safer for artificial intelligence. There was never any question that this technology has a bright future ahead, only when that future will come. As is usually the case with new technologies that manage to cast a glint in investors' eyes as soon as they come out of the laboratory, AI was oversold. It simply had to wait for enough software developers to generate applications which enough people could use. The first such program appeared this year, according to *The New York Times* and industry newsletters *Expert Systems Strategies* and *RELease 1.0*.

Timed for the season that ended this past April 15, it was an expert tax preparation program that runs on IBM or compatible personal computers. Fortunately for the AI field, it was not only a good expert system but also a finely crafted and friendly program that drew the top rating from *Business Week* magazine's review of income tax software.

Ironically, AI pioneer Symbolics Inc. had no taxes to pay during this season. The leading developer of Lisp machines — computers specialized for the development of expert systems with the Lisp language — incurred massive losses last year, even as its sales doubled from the previous year. This, after five years of more than doubling sales every year and placing seventh among ELECTRONIC BUSINESS' fastest growing companies.

Even though Symbolics is deemed representative of the AI field, its problems are not. Quite the contrary. All AI companies have known that, for AI to expand its market, the expert systems it generates must run on low-cost personal computers or workstations. But, as developers have become more proficient in this technology, they have learned to do the development also in general-purpose personal computers or workstations. These not only cost less than Lisp machines, but can also be used for other applications.

Like Symbolics, Compaq doubled its sales last year. But, unlike Symbolics, Compaq was very profitable, and its profits more than tripled. Besides, Compaq is a much larger company — its sales exceeded $1.2 billion this year, and show every sign of doubling again in 1988. The same can be said about workstation leader Sun Microsystems Inc. ELECTRONIC BUSINESS ranked this company as the fastest growing among computer and electronics companies, based on average growth over the period from 1982-1987. Little of these companies' growth came from AI applications, but they can look to AI as a source of growth for the next five years, even if few users care about a product's roots in AI, only that it is a good program.

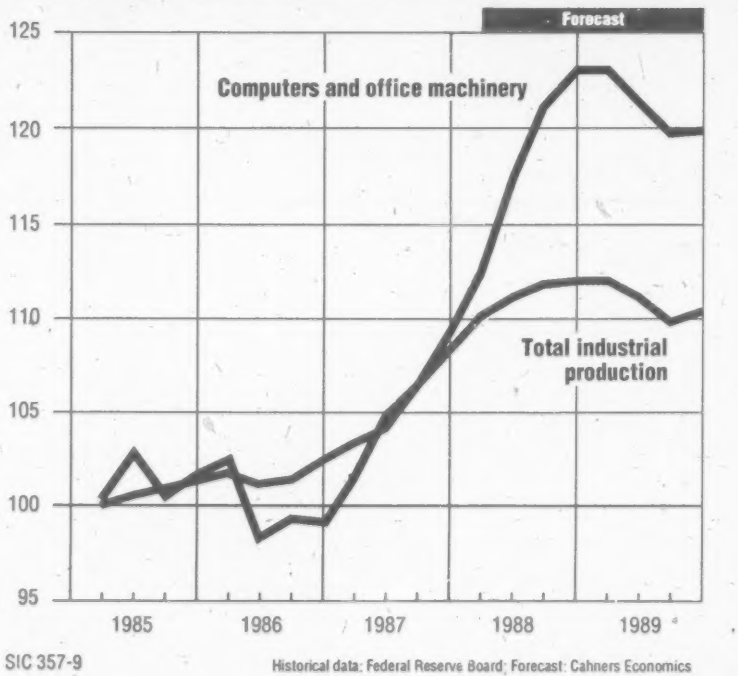
The production of companies such as Compaq, Sun Microsystems and Symbolics, contributes to what the Federal Reserve Board measures as the industrial production index for SIC 357-9, for "computer and office machinery." This index, which traditionally has grown faster than the country's overall index of industrial production, faltered in 1986 when it declined for the first time even as the overall industrial activity kept growing. Fortunately, SIC 357-9 is back to its winning ways. It increased by 6% in 1987, as opposed to the respectable 4% for all industry, and Cahners Economics expects the relative growth of computer production to accelerate with 12%, versus 5% for all industry in 1988.

Moreover, says senior economist Elizabeth Baatz, the value added by computer manufacturing in the United States may already account for 6.5% of the value added by all industries. This is likely to increase as AI gets to the public, even after the tax season is over.

ALBERTO SOCOLOVSKY

Computers and office machinery production index

Quarterly averages, 1st quarter 1985 = 100, seasonally adjusted



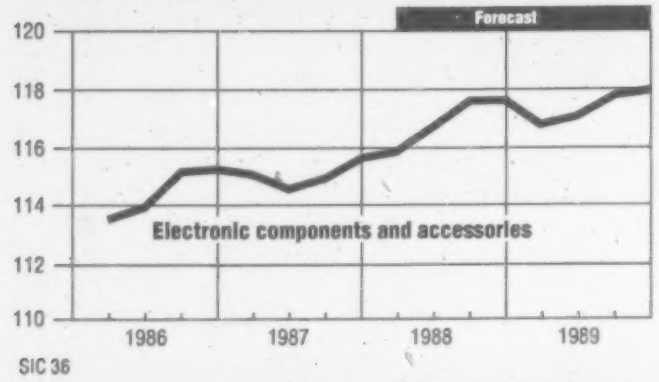
SIC 357-9

Historical data: Federal Reserve Board; Forecast: Cahners Economics

PPI Active components — May 15

Producer price index — Electronic components

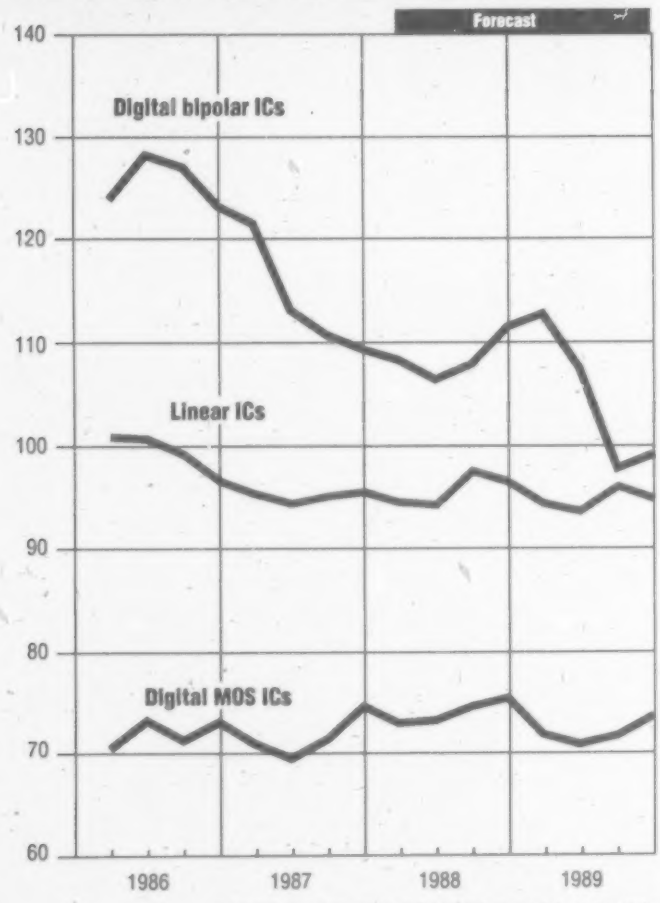
Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Active components

Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Calm market holds price increases to minimum

Supply and demand conditions for most electronic components remained on an even keel in the first quarter of 1988. The Bureau of Labor Statistics reports that producer prices of electronic components rose 1.4% in the first three months of the year compared with the year-ago period. Prices are rising, compared with a 0.2% components inflation rate in the last quarter of 1987.

Still, the U.S. electronics industry recovery will soon be entering its third year and supplies remain fairly abundant by past standards. Capacity constraints, except for advanced submicron components, are rare.

Electronics Purchasing's survey of buyers shows leadtimes — the length of time between placement of an order and delivery — stretching only one or two weeks above last year.

Cahners Economics expects leadtimes to be peaking by this summer. But compared with 1984, leadtimes will not be a significant problem. For instance, leadtimes for digital ICs, at nearly seven weeks in March 1988, will top out at nine weeks this summer, far below the 22-week leadtime seen back in 1984.

The comparative calm in these markets will hold price increases to a minimum for digital bipolar, digital MOS and linear ICs. Digital bipolar producer prices slipped 10.6% in the first quarter of 1988 compared with early 1987. These prices are expected to end the year 4.5% below 1987.

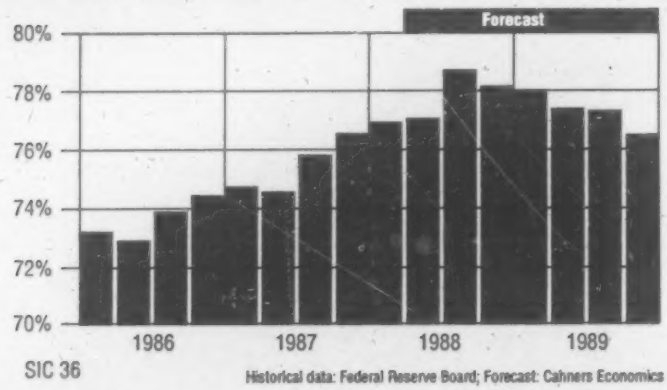
Producer prices for digital MOS rose 4.0% in early 1988, increasing from the 0.6% gain seen in 1987. Price increases for these products will most likely hold in the 4% to 5% range.

Linear IC prices fell 0.7% early this year. The deflationary trend was more severe in 1987. By the end of 1988, linear IC prices are expected to have risen slightly above 1987 levels.

Plant utiliz — May15

Plant utilization — Electrical machinery

Average percentage of capacity utilized per quarter, seasonally adjusted

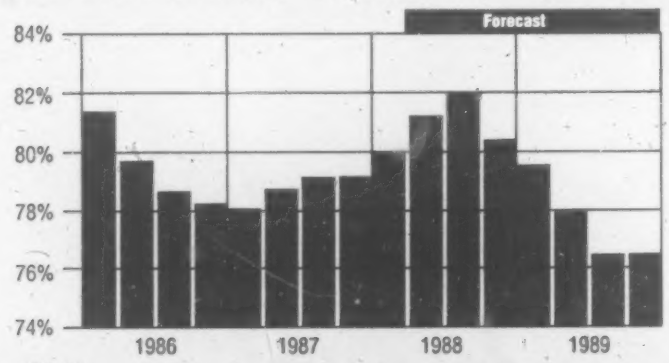


SIC 36

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Instruments

Average percentage of capacity utilized per quarter, seasonally adjusted

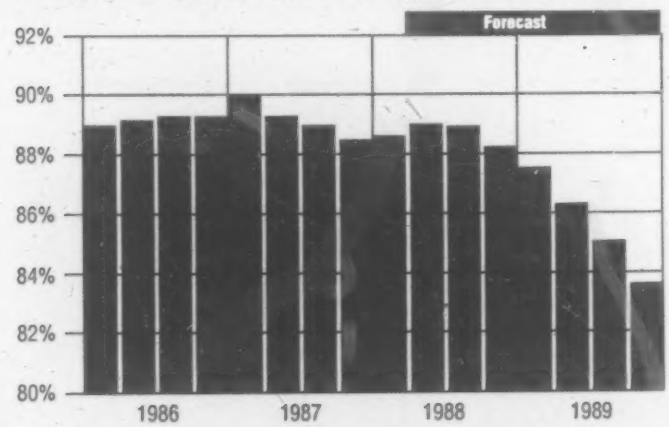


SIC 38

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Aerospace

Average percentage of capacity utilized per quarter, seasonally adjusted



SIC 37

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Survey suggests increase in capacity utilization

Manufacturing capacity is on the rise. Rising merchandise exports, increasing productivity in the manufacturing sector, and a generally strong domestic economy are starting to put pressure on U.S. industrial capacity.

Process industries like paper and chemicals are under the most pressure from lack of excess capacity. These industries contributed to an increase in the percent of capacity utilized in manufacturing facilities from 79.6% at the beginning of 1987 to 82.5% by the end of last year. The last time utilization rates were this high was in early 1980. And the last time they increased this much was in 1983.

The electronics and electrical machinery industry is still operating at 76.6% of capacity. At the beginning of 1987, capacity utilization stood at 75%. Although the Commerce Department doesn't break out the electronics industry in their survey, evidence from *Electronics Purchasing's* survey of electronics manufacturers suggests capacity constraints in the electronics industry are tighter. But neither the Commerce Department's survey of electronic/electrical industries, nor *Electronics Purchasing's* survey of electronics manufacturers have shown a steep rise in capacity utilized over the past 12 months.

Until early 1988, the instruments industry seemed to be following in the sedate path of the electrical machinery industry. From January to December 1987, the instruments capacity utilization rate rose less than one percentage point. Then, from 78.1% capacity utilized in December 1987, factory utilization rose to 80.4% in February 1988.

Meanwhile, the aerospace industry experience has been vastly different. With defense dollars pouring in, capacity utilization at aerospace plants hit 90% in March 1987. The last time this industry saw such a high utilization rate was in 1980, and then the rate was still only 87%. The trend now for aerospace: with production headed down, utilization rates are sure to follow suit.

Back on track

The value of new orders and shipments for computers and office machinery skyrocketed in January from their fourth-quarter doldrums.

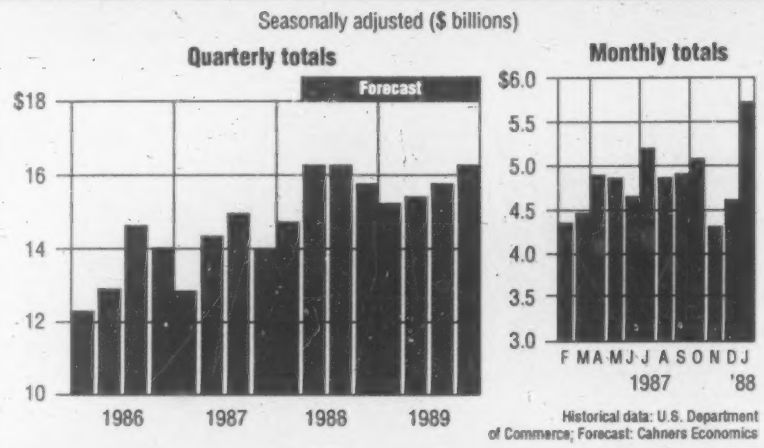
New orders came in at $5.69 billion, a 24.2% increase from December 1987 and the highest monthly level since February 1985.

January shipments totaled $5.67 billion, a 17.6% increase from December and the highest monthly level ever recorded on a seasonally adjusted basis.

The month-to-month double-digit surge for new orders and shipments is a correction to the panic reaction in November when new orders plummeted 15% and shipments toppled 13%. The healthy rebound now gets the computer industry recovery back on track.

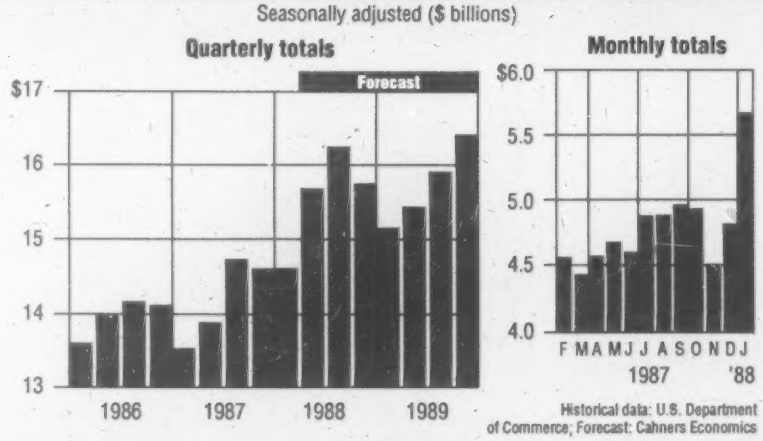
The monthly trade figures for December brought the year-end 1987 value of computers and office machinery exports to $18.7 billion, 21% greater than the value in 1986. Imports grew 26% in 1987 to total $19 billion.

Computers and office machinery — New orders



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computers and office machinery — Shipments



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, January)	302.4	299.20	+1.07%	265.7	+13.81%	330.0	+9.13%
Shipments (SA, $ millions, January)	$5,668	$4,818	+17.64%	$4,532	+25.07%	$5,050	-10.91%
New orders (SA, $ millions, January)	$5,690	$4,582	+24.18%	$4,072	+39.73%	$5,071	-10.88%
Unfilled orders (SA, $ millions, January)	$18,902	$18,680	+1.19%	$18,769	+0.71%	$20,062	+6.14%
Inventory-to-shipment ratio (SA, January)	1.76	2.06	—	2.16	—	2.13	—
All employees (thousands, January)	468.2	470.1	-0.40%	457.9%	+2.25%	489.2	+4.49%
Production workers (thousands, January)	153.1	153.7	-0.39%	149.5	+2.41%	157.6	+2.96%
Exports ($ millions, December)	$1,869	$1,884	-0.76%	$1,451	+28.81%	$1,798	-3.81%
Imports ($ millions, December)	$1,903	$1,784	+6.65%	$1,259	+51.14%	$1,775	-6.69%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

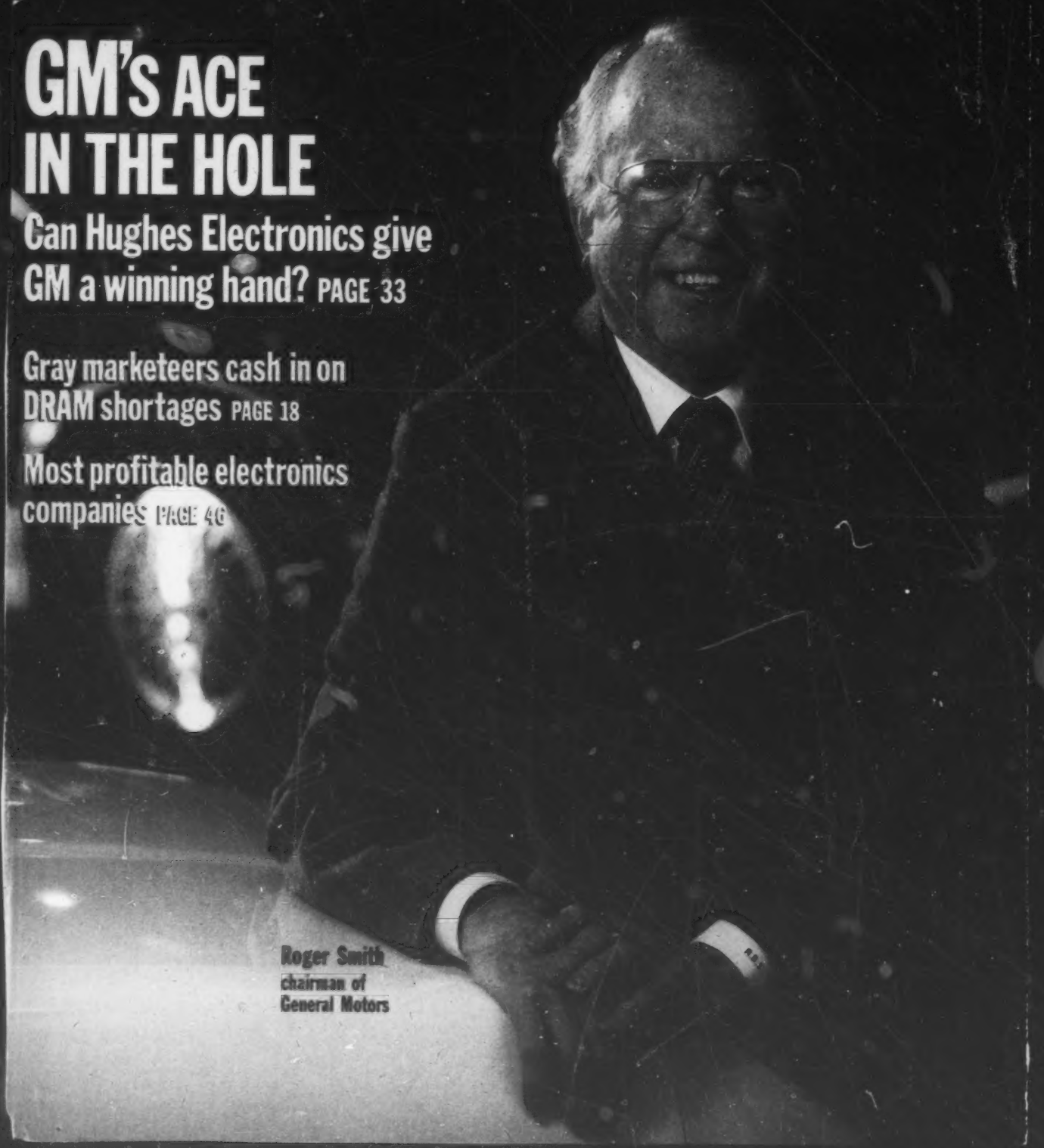
JUNE 1, 1988

GM'S ACE IN THE HOLE

Can Hughes Electronics give GM a winning hand? PAGE 33

Gray marketeers cash in on DRAM shortages PAGE 18

Most profitable electronics companies PAGE 46



Roger Smith
chairman of
General Motors

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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34 GM's ace in the hole

GM-bashers have had a field day in recent years as the auto giant has spent lavishly but ineffectually on acquisitions and plant automation. But one of Roger Smith's spending sprees—the $5 billion purchase of Hughes Aircraft—offers hope of straightening out GM's manufacturing mess. Hughes' expertise in systems engineering could give Smith the last laugh.

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Basic Four has hit the fast track since it bought back its Canadian subsidiary and began targeting vertical markets.

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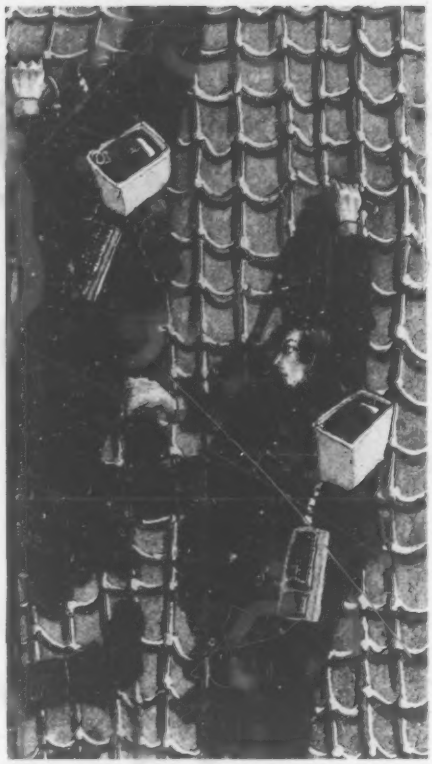

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Don't ignore Detroit

Don't just think of the auto industry as a purchaser of electronics equipment. And don't just think of it as beginning and ending in Detroit, either. As Norm Alster, our managing editor for special projects, points out, the futures of the global auto and electronics industries are becoming increasingly intertwined. General Motors alone boasts electronics operations that generate revenue close to that of AT&T. And Japan's automotive giants are accelerating use of electronics in cars and applying ever higher tech procedures to their production.

To help electronics executives understand how to sell to, partner with and even compete with their automotive counterparts, Norm is assembling a four-part series that examines the electronics strategies of the auto empires: GM, Ford, Chrysler and Japan. We begin with a look at GM's infatuation with and successful application of electronics in manufacturing.

We think this series will become required reading not only for vendors of the parts and equipment that the auto industry buys in increasing quantities, but for anyone wanting to know how the GMs and Fords are redefining everything from technology-transfer techniques to quality standards for semiconductors.

Junebug Clark

GM chairman Roger B. Smith, at right, with Norm Alster

Electronics *glasnost*

Reagan and Gorbachev haven't limited their third summit to disarmament discussions; trade has been on the agenda, too. In April, Commerce Secretary William Verity took to Moscow a trade mission of 500 U.S. businessmen, all eager to ink pacts with the Soviets. In our "Business Trends" story, associate editor Beth Karlin looks at how detente between the superpowers bodes well for U.S. electronics firms, as well.

Got the blues? Get the grays

Desperate for DRAMs? Distributors have put you on allocation? Not to worry: the gray market will happily sell you unauthorized parts for outrageous prices. Contributing editor Michael Leibowitz tells how the gray marketeers are becoming the expensive answer to the prayers of many a parts-hungry systems company.

AL FURST

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VBPA ABP

Hot line to high growth for PBXs doing voice *and* data

Integrated switching exchanges are giving the PBX market its only strong growth. But usage is hardly widespread

Today's users of private branch exchanges don't just want equipment that handles voice communications. Nor are they satisfied only with PBXs dedicated to computer data. What they'd prefer are exchanges that deal with voice and data simultaneously.

That preference is one that PBX makers like Rolm, AT&T, and Northern Telecom Inc. are responding to. According to Boston-based consultancy the Yankee Group, U.S. shipments of data lines in integrated PBXs grew by about 40% last year, as did revenue: from $234 million in 1986 to $304 million in 1987 and climbing to $548 million by 1990. That is in striking contrast to the performance of the PBX market as a whole, which increased by only 5% in the same period.

The push toward integrated PBXs has competitive implications for vendors of other communications links such as LANs. And it will play a significant role in development of the integrated services digital network (ISDN) technology that combines voice and data on the same phone line, and which is of considerable interest to telecom equipment makers across the United States.

However, voice/data PBXs have not yet made much of a mark. The Yankee Group notes that data line PBX shipments are currently 6% to 7% of total PBX shipments, and that the installed base of data lines is a mere 3% of the total PBX lines installed in 1987. The reason, simply put: applications are driving the market, rather than the technology.

Hesitations

Three main factors contribute to development of the voice/data PBX market: applications requirements, price-performance and the impact of other existing technologies. The major applications concerns are in operating standards and in compatibility with existing telecom systems. To overcome customers' hesitations in investing in this new technology, the current products are touted as having standard interfaces and even as being "ISDN ready." AT&T, with its series 75 and 85 digital PBXs, claims it meets the primary rate interface (PRI), an interface standard conforming to the CCITT's ISDN specifications and which AT&T says enables different devices to be connected to the host. Northern Telecom also focuses on ISDN architecture standards.

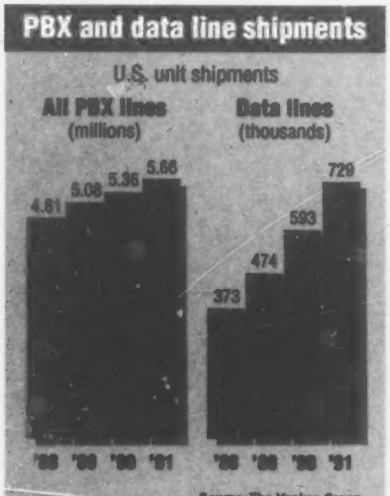
Cost payoff is another crucial factor, especially for those currently using LANs. According to the Yankee Group, adding a data line could cost from $450 up to $1,200, while having data PBXs (non-voice switching) costs only $150 per port.

And PBXs need to pick up the pace. LAN networking speeds of 10 megabits per second (Mbps) are common today, while packet switching can only reach 2Mbps and 64Kbps in non-packet switching networks. As David Yedwad, a researcher at PBX market analysis firm The Eastern Management Group, comments, voice/data PBXs provide "little solution powerful enough to make people change their minds."

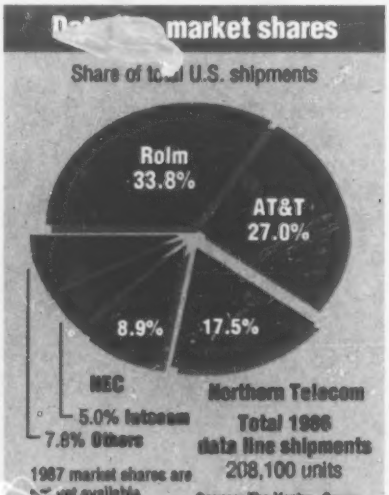
However, major makers of integrated PBXs hold a different view. Jay Misra, program manager for the 9751 systems at IBM offshoot Rolm, which together with AT&T and Northern Telecom holds 78% of the integrated PBX market, does not consider the low-speed transmission on PBXs a drawback; instead, he looks at it as a market niche that the new PBXs should fill. To him, voice/data PBXs are not competing with other networking technologies, because "market applications require a range of networking alternatives." All of the PBXs shipped by market leader Rolm have 20% of their lines committed to data switching.

The market for voice/data PBXs is expected to grow by 20% to 25% annually through the early 1990s, and costs will fall: the Yankee Group predicts that the price per data line will drop by an average of 3% each year, due largely to improved IC functionality. In general, the price will drop from about $1,000 in 1987 down to $900 in 1991. By coexisting rather than competing with other network technologies, voice/data PBX applications are expected to exceed those for data-only PBXs, ranking in third place behind direct wiring and LANs.

LIN SUN



Compared with the total PBX market, sales of data lines are taking off



Rolm and AT&T own the largest slices of the fast-growing data-line segment

The proof is in the profits: 1987 wasn't half bad

With their new lean and mean look, top electronics companies posted profit gains last year. Software firms were winners; distributors weren't

BY BRUCE C.P. RAYNER and LINDA STALLMANN

Despite the October stock market crash, 1987 was a good year for the bottom line in electronics. Export sales grew as a result of the cheaper dollar, a lower corporate tax rate took effect and the painful corporate paring-down purge started to pay off. As a result, electronics companies are now leaner, meaner and more competitive than they were a year ago.

The ELECTRONIC BUSINESS 100 most profitable electronics companies posted a weighted average after-tax profit rate of 7.8% in 1987, up from 6.7% in 1986. But whether or not profits will continue their upward climb in 1988 will depend on each industry segment's overall market strength and the strength of the economy, experts say.

Looking out to 1991, Stanley Feldman, an economist and senior vice president with research firm Data Resources Inc., expects electronics to post above average cash flow — an estimate of net income — of around 8.5% to 9%. Cash flow for electronic components will grow at a 10% rate between 1987 and 1991, Feldman forecasts, while communications equipment will grow at a 9.5% rate and computers at a slower 7.5% rate.

But for stellar performers, industry averages have little to do with individual performance. For the second year in a row, the high flier on the ELECTRONIC BUSINESS list of most profitable companies is Minneapolis-based Cray Research Inc., maker of multimillion dollar supercomputers. Cray posted a 21.4% profit margin in 1987, up from its 20.9% performance in 1986. William Easterbrook, an industry analyst with investment brokerage Kidder Peabody & Co., expects Cray to top the list again next year, but believes the halcyon days for the mega-mainframe maker are drawing to a close. "I expect their profitability over this year and the next few years will decline because of product transition and increasing competition from the low end," he says.

Overall, the computer segment of electronics improved its profitability in 1987 to 9.4%, up from 8.1% in 1986. As a whole, the 21 computer makers account for 58% of total revenue of the top 100 companies on the list. Part of the improvement in profits for computer vendors is the result of restructuring, industry experts say. For instance, analyst Easterbrook expects IBM's 1988 profit rate to improve from a 9.7% rate in 1987 to 10% this year, partly as a result of its early retirement program.

Marty Braun

The award for the outstanding industry segment goes to a first-time entrant on the ELECTRONIC BUSINESS most profitable list: software. Although it accounts for less than 1% of total revenue of the 100 companies, software puts all other electronics segments to shame with an average profitability rate of 16.5% for 1987. Of the top five most profitable companies, three are software companies: Microsoft Corp.; Lotus Development Corp.; and Ashton-Tate Corp., in that order.

The only segment on the list to post a decline in profitability for 1987 was office equipment, dropping from a 7.8% profit rate in 1986 to 5.3%. The reason is that Xerox Corp., the largest office equipment vendor on the list, posted a profit rate of only 3.9%, and IBM, which was classified as an office equipment maker last year, was reclassified as a computer company this year.

Similarly, electronics distribution completely missed the boat this year. With five entrants for 1986, the distributors were still suffering from tough times. Sagging margins and overstocked shelves resulted in poor profit performance. Typically, distribution is often the last industry segment to benefit from a recovery.

On the other hand, the defense industry, renowned for its cries of declining profits, came through in 1987 with a respectable showing. In all, eight defense contractors made the top 100 list, posting an average 4.6% profit rate in 1987, up from a meager 2.9% in 1986.

To qualify for the top 100 most profitable list, companies must be publicly held and have at least 70% of their sales in electronics. Also, total fiscal year 1987 sales must top $80 million. Profits are calculated after taxes but before any extraordinary items, to reflect as best as possible earnings from operations. No adjustment is made for differences in fiscal years. □

1987's most profitable companies

1987 rank	Company	Net profit as a percentage of revenue	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
1	Cray Research	21.4%	$687.3	$147.1	12/87	Minneapolis, Minn.
2	Microsoft	20.8%	345.9	71.9	6/87	Redmond, Wash.
3	Lotus Development	18.2%	395.6	72.0	12/87	Cambridge, Mass.
4	Ashton-Tate	16.1%	267.3	43.1	1/88	Torrance, Calif.
5	Cincinnati Microwave	15.2%	80.9	12.3	12/87	Cincinnati, Ohio
6	Digital Communications	14.9%	181.4	27.0	6/87	Alpharetta, Ga.
7	Medtronic	14.7%	502.0	73.8	4/87	Minneapolis, Minn.
8	Seagate Technology	14.6%	958.1	139.7	6/87	Scotts Valley, Calif.
9	Sensormatic Electronics	14.0%	98.3	13.8	5/87	Deerfield Beach, Fla.
10	Intel	13.0%	1,907.1	248.1	12/87	Santa Clara, Calif.
11	Maxtor	12.8%	175.3	22.4	3/87	San Jose, Calif.
12	DEC	12.1%	9,389.4	1,137.4	6/87	Maynard, Mass.
13	Oracle	11.9%	131.3	15.6	3/87	Belmont, Calif.
14	Measurex	11.8%	227.4	26.8	11/87	Cupertino, Calif.
15	Atari	11.6%	493.2	57.4	12/87	Sunnyvale, Calif.
16	Molex	11.2%	386.8	43.4	6/87	Lisle, Ill.
17	Compaq	11.1%	1,224.1	136.3	12/87	Houston, Texas
18	Evans & Sutherland	11.0%	134.4	14.7	12/87	Salt Lake City, Utah
19	Intergraph	10.9%	641.1	69.9	12/87	Huntsville, Ala.
20	AMP	10.8%	2,318.0	250.0	12/87	Harrisburg, Pa.
21	Stratus Computer	10.5%	184.2	19.4	12/87	Marlboro, Mass.
22	Tandem Computers	10.2%	1,035.5	105.6	9/87	Cupertino, Calif.
23	3Com	10.1%	110.4	11.1	5/87	Santa Clara, Calif.
24	Aydin	9.9%	149.2	14.8	12/87	Horsham, Pa.
25	IBM	9.7%	54,217.0	5,258.0	12/87	Armonk, N.Y.
26	Micropolis	9.4%	288.3	27.2	12/87	Chatsworth, Calif.
27	Amdahl	9.4%	1,505.2	142.0	12/87	Sunnyvale, Calif.
28	Gerber Scientific	9.4%	223.9	21.1	4/87	South Windsor, Conn.
29	Analogic	9.3%	155.4	14.5	7/87	Peabody, Mass.
30	Telex	9.3%	840.7	77.9	3/87	Tulsa, Okla.
31	Western Digital	9.3%	462.5	42.8	6/87	Irvine, Calif.
32	Mentor Graphics	9.2%	221.8	20.3	12/87	Beaverton, Ore.
33	ADC Telecommunications	9.1%	166.9	15.3	10/87	Bloomington, Ind.
34	Pitney Bowes	8.9%	2,250.5	199.4	12/87	Stamford, Conn.
35	MiniScribe	8.6%	362.5	31.1	12/87	Longmont, Colo.
36	Loral	8.3%	690.0	57.5	3/87	New York, N.Y.
37	Plantronics	8.2%	111.5	9.1	5/87	San Jose, Calif.
38	Apple Computer	8.2%	2,661.1	217.5	9/87	Cupertino, Calif.
39	Diebold	8.1%	439.1	35.8	12/87	Canton, Ohio
40	Ask Computer	8.1%	98.3	8.0	6/87	Los Altos, Calif.
41	Ultimate	8.0%	172.9	13.8	4/87	East Hanover, N.J.
42	Hewlett-Packard	8.0%	8,090.0	644.0	10/87	Palo Alto, Calif.
43	Dynatech	7.6%	304.7	23.2	3/87	Burlington, Mass.
44	NCR	7.4%	5640.7	419.3	12/87	Dayton, Ohio
45	Quantum	7.3%	120.8	8.8	3/87	Milpitas, Calif.
46	QMS	7.3%	119.4	8.7	9/87	Mobile, Ala.
47	MAI Basic Four	7.1%	321.0	22.8	9/87	Tustin, Calif.
48	Tandy	7.0%	3,452.2	242.3	6/87	Fort Worth, Texas
49	Wyse Technology	7.0%	260.0	18.1	3/87	San Jose, Calif.
50	Archive	6.9%	88.8	6.1	9/87	Costa Mesa, Calif.

Net profits are from continuing operations after taxes and before extraordinary items

Source: ELECTRONIC BUSINESS

(Continued)

1987's most profitable companies

1987 rank	Company	Net profit as a percentage of revenue	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
51	Sun Microsystems	6.8%	$537.5	$36.3	6/87	Mountain View, Calif.
52	Prime Computer	6.7%	960.9	64.8	12/87	Natick, Mass.
53	Watkins-Johnson	6.7%	264.3	17.8	12/87	Palo Alto, Calif.
54	Applied Magnetics	6.7%	211.9	14.2	9/87	Goleta, Calif.
55	Computer Consoles	6.5%	148.4	9.6	12/87	Waltham, Mass.
56	AST Research	6.3%	206.0	13.0	6/87	Irvine, Calif.
57	Altos Computer	6.3%	153.9	9.7	6/87	San Jose, Calif.
58	MTS Systems	6.3%	113.1	7.1	9/87	Minneapolis, Minn.
59	Intelligent Systems	6.2%	163.2	10.2	12/87	Norcross, Ga.
60	Micom Systems	6.2%	196.7	12.2	3/87	Simi Valley, Calif.
61	Unisys	6.0%	9,712.9	578.0	12/87	Detroit, Mich.
62	Tandon	5.9%	289.1	17.1	12/87	Chatsworth, Calif.
63	AVX	5.8%	271.9	15.8	12/87	Great Neck, N.Y.
64	Computer & Communications	5.7%	98.8	5.7	12/87	San Diego, Calif.
65	Diasonics	5.7%	267.6	15.2	12/87	South San Francisco, Calif.
66	Eldec	5.6%	99.4	5.5	3/87	Lynnwood, Wash.
67	Triad Systems	5.5%	117.3	6.4	9/87	Livermore, Calif.
68	Qantel	5.4%	88.0	4.8	4/87	Parsippany, N.J.
69	Avantek	5.4%	213.7	11.6	12/87	Santa Clara, Calif.
70	Electrospace Systems	5.3%	190.7	10.1	3/87	Richardson, Texas
71	Analog Devices	5.0%	370.4	18.7	10/87	Norwood, Mass.
72	GM Hughes Electronics	5.0%	10,481.0	521.1	12/87	Detroit, Mich.
73	E-Systems	4.9%	1,227.2	60.4	12/87	Dallas, Texas
74	Regency Electronics	4.9%	495.3	24.3	6/87	Indianapolis, Ind.
75	Scientific-Atlanta	4.9%	495.3	24.3	6/87	Atlanta, Ga.
76	Lee Data	4.7%	114.5	5.4	3/87	Minneapolis, Minn.
77	Veeco Instruments	4.7%	195.6	9.2	9/87	Melville, N.Y.
78	VLSI Technology	4.7%	172.0	8.1	12/87	San Jose, Calif.
79	DSC Communications	4.7%	312.4	14.6	12/87	Plano, Texas
80	Motorola	4.6%	6,700.0	308.0	12/87	Schaumburg, Ill.
81	Texas Instruments	4.6%	5,594.5	256.9	12/87	Dallas, Texas
82	Nicolet Instruments	4.5%	121.6	5.4	3/87	Madison, Wis.
83	Recognition Equipment	4.2%	264.7	11.2	10/87	Dallas, Texas
84	LSI Logic	4.1%	262.1	10.7	12/87	Milpitas, Calif.
85	Systems Industries	4.1%	119.5	4.9	7/87	Milpitas, Calif.
86	Harris	4.1%	2,079.0	84.5	6/87	Melbourne, Fla.
87	CTS	4.0%	261.1	10.5	12/87	Elkhart, Ind.
88	Apollo Computer	3.9%	553.7	21.7	12/87	Chelmsford, Mass.
89	Xerox	3.9%	14,900.0	578.0	12/87	Stamford, Conn.
90	ISC Systems	3.9%	168.5	6.5	6/87	Spokane, Wash.
91	Honeywell	3.8%	6,679.3	253.7	12/87	Minneapolis, Minn.
92	Varo	3.7%	95.3	3.5	4/87	Garland, Texas
93	Augat	3.7%	313.2	11.5	12/87	Mansfield, Mass.
94	Tektronix	3.7%	1,395.9	51.2	5/87	Beaverton, Ore.
95	Wavetek	3.7%	82.5	3.0	9/87	San Diego, Calif.
96	Mark IV Industries	3.5%	291.5	10.2	2/87	West Amherst, N.Y.
97	Genicom	3.5%	302.2	10.5	12/87	Waynesboro, Va.
98	Silicon Systems	3.5%	81.8	2.8	9/87	Tustin, Calif.
99	Dynascan	3.4%	191.6	6.6	12/87	Chicago, Ill.
100	Emulex	3.4%	103.8	3.5	6/87	Costa Mesa, Calif.

Net profits are from continuing operations after taxes and before extraordinary items

Source: ELECTRONIC BUSINESS

(Continued)

1987's most profitable companies by industry segment

Software

	Net profit as a percentage of revenue	1987 rank
Microsoft	20.8%	2
Lotus Development	18.2%	3
Ashton-Tate	16.1%	4
Oracle	11.9%	13
Ultimate	8.0%	41
Weighted average	**16.5%**	

Computers

	Net profit as a percentage of revenue	1987 rank
Cray Research	21.4%	1
Digital Equipment	12.1%	12
Atari	11.6%	15
Compaq Computer	11.1%	17
Stratus Computer	10.5%	21
Tandem Computers	10.2%	22
3Com	10.1%	23
IBM	9.7%	25
Amdahl	9.4%	27
Analogic	9.3%	29
Telex	9.3%	30
Apple Computer	8.2%	38
MAI Basic Four	7.1%	47
Tandy	7.0%	48
Sun Microsystems	6.8%	51
Prime Computer	6.7%	52
Altos	6.3%	57
Unisys	6.0%	61
Computer & Communications	5.7%	64
Qantel	5.4%	68
Apollo Computer	3.9%	88
Weighted average	**9.4%**	

Components

	Net profit as a percentage of revenue	1987 rank
Molex	11.2%	16
AMP	10.8%	20
AVX	5.8%	63
Eldec	5.6%	66
Veeco Instruments	4.7%	77
CTS	4.0%	87
Augat	3.7%	93
Weighted average	**9.0%**	

Peripherals

	Net profit as a percentage of revenue	1987 rank
Seagate Technology	14.6%	8
Maxtor	12.8%	11
Micropolis	9.4%	26
MiniScribe	8.6%	35
Quantum	7.3%	45
QMS	7.3%	46
Wyse Technology	7.0%	49
Archive	6.9%	50
Applied Magnetics	6.7%	54
Intelligent Systems	6.2%	59
Tandon	5.9%	62
Lee Data	4.7%	76
Systems Industries	4.1%	85
Genicom	3.5%	97
Emulex	3.4%	100
Weighted average	**8.9%**	

Computer-based systems

	Net profit as a percentage of revenue	1987 rank
Measurex	11.8%	14
Evans & Sutherland	11.0%	18
Intergraph	10.9%	19
Mentor Graphics	9.2%	32
Ask Computer Systems	8.1%	40
Computer Consoles	6.5%	55
Triad Systems	5.5%	67
Recognition Equipment	4.2%	83
ISC Systems	3.9%	90
Mark IV Industries	3.5%	96
Weighted average	**7.9%**	

Capital equipment

	Net profit as a percentage of revenue	1987 rank
Gerber Scientific	9.4%	28
Hewlett-Packard	8.0%	42
MTS Systems	6.3%	58
Nicolet Instruments	4.5%	82
Tektronix	3.7%	94
Wavetek	3.7%	95
Weighted average	**7.3%**	

Semiconductors

	Net profit as a percentage of revenue	1987 rank
Intel	13.0%	10
Western Digital	9.3%	31
Analog Devices	5.0%	71
VLSI Technology	4.7%	78
Texas Instruments	4.6%	81
LSI Logic	4.1%	84
Silicon Systems	3.5%	98
Weighted average	**6.6%**	

Office equipment

	Net profit as a percentage of revenue	1987 rank
Pitney Bowes	8.9%	34
Diebold	8.1%	39
NCR	7.4%	44
Xerox	3.9%	89
Weighted average	**5.3%**	

Communications

	Net profit as a percentage of revenue	1987 rank
Cincinnati Microwave	15.2%	5
Digital Communications	14.9%	6
Aydin	9.9%	24
ADC Telecommunications	9.1%	33
Dynatech	7.6%	43
Micom Systems	6.2%	60
Avantek	5.4%	69
Scientific-Atlanta	4.9%	75
Regency Electronics	4.9%	74
DSC Communications	4.7%	79
Motorola	4.6%	80
Dynascan	3.4%	99
Weighted average	**5.2%**	

Government

	Net profit as a percentage of revenue	1987 rank
Loral	8.3%	36
Watkins-Johnson	6.7%	53
Electrospace Systems	5.3%	70
GM Hughes Electronics	5.0%	72
E-Systems	4.9%	73
Harris	4.1%	86
Honeywell	3.8%	91
Varo	3.7%	92
Weighted average	**4.6%**	

Net profits are from continuing operations after taxes and before extraordinary items.
Source: Electronic Business

Chip gear: Korea's appetite is not the U.S.'s delight

Korea's market for semiconductor materials and production equipment remains robust. Why are U.S. companies not ecstatic?

BY OLES GADACZ

South Korea's electronics industry is booming. In particular, Korea is looking to export $885 million worth of chips this year — double last year's $439 million. Accordingly, the country's semiconductor makers are planning to expand their plants, providing ample opportunity for suppliers of materials and manufacturing machinery. Indeed, the top four Korean chip companies will spend more than $450 million on capital equipment this year. Because Korea has no semiconductor infrastructure to speak of, the country will have to depend on foreign vendors.

But U.S. suppliers of semiconductor materials and production equipment are hardly ecstatic. Korea's imports of U.S. electronic goods were less than half the $2.7 billion bought from Japan in 1986. In the same year, North America ran up a $2.6 billion deficit in its trade of electronic goods with Korea. In contrast, Japan managed a $2.1 billion surplus.

Pricing appears to be the No. 1 culprit. "If we have a price war, we can't beat the Japanese. They'll cut prices 50%. No U.S. company can do that," sighs S.K. Suh, president of Varian Korea Ltd., the Korean subsidiary of Varian Associates Inc., headquartered in Palo Alto, Calif.

Even with the yen value soaring vis-à-vis the dollar's plummet, Japanese companies have continued their aggressive pricing practices. "The Japanese . . . seem to be getting more market share even though their yen is going up. They're as powerful as ever," observes Lim In Sang, branch manager for Perkin-Elmer Korea Corp.

The Japanese maintain that their price slashing reflects their lofty philosophy of pursuing market share at the expense of short-term profits. Others, however, contend that the Japanese way of doing business is anything but admirable. "Once they hook a customer on their system and support, it's difficult [for the customer] to choose another vendor," asserts Lim. Adds customer Yang Jae Kyu, an engineer with Daewoo Telecom Company Ltd., "For the Japanese, the initial quoted price is just a starting point. It doesn't mean anything. . . . They make up for their low prices with high-priced spare parts [later on]."

Goldstar, historically a customer of U.S. machinery, will probably be buying more Japanese gear in the future, says Song Dae Ho, a Goldstar director

Punching in and out

Customer support is another reason why Koreans prefer to deal with the Japanese, in spite of deep-seated animosities between the two peoples. Koreans detect the Japanese willingness to please the customer at any cost. Song Dae Ho, a director in charge of semiconductor manufacturing at Goldstar Semiconductor Company Ltd., faults U.S. service personnel for their "punch in and punch out" approach to work. In contrast, Song notes that the Japanese will work overnight, if necessary, to assist customers. "If we have problems, they answer immediately and fly in the next day. That's the difference," says Song.

Consequently, Song says that Goldstar is leaning toward buying more from the Japanese even though

the company has traditionally bought American. "In our case, 70% of our equipment comes from the U.S.," he says. "[But] recently we've introduced Japanese equipment and I think Japanese equipment will occupy a higher percentage in the future."

The United States' loss of Goldstar's business could be considerable. The company will spend $100 million this year for capital equipment procurement alone. And Goldstar has no plans of slowing down; it has announced an annual budget of $100 million for the next five years. In particular, the company surprised the semiconductor industry with its announcement last December that it was planning to mass produce 1-megabit DRAM chips at its Gumi facility this year.

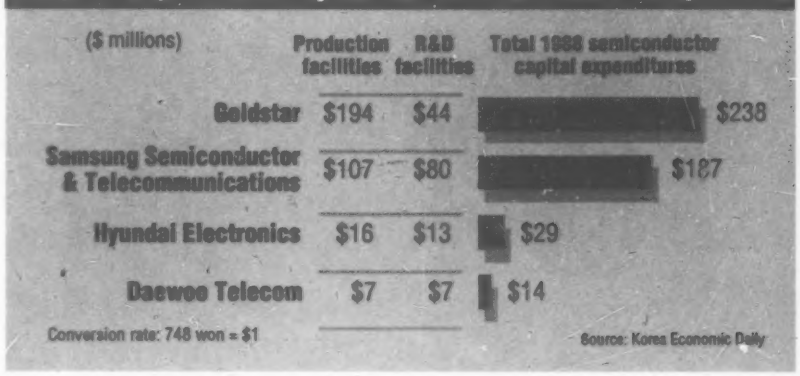
Goldstar's heavy spending has not gone by unnoticed. "We're worried that they're starting to lean more toward the Japanese," says Suh of Varian, which claims 75% of the Korean sputtering systems market and an 85% share of the country's ion implanters market.

Sometimes the problem is that the U.S. equipment has failed to live up to expectations. Rumor has it that Hyundai Electronics Industries Company Ltd. has had problems with the yields of its 256-kilobit DRAMs because of U.S. steppers. Consequently, the company is reportedly looking to buy the same equipment from a Japanese supplier. Hyundai officials would not comment.

Still, perhaps because of political pressures brought on by United States-Korea trade friction, some Korean companies seem determined to buy American. In Kiheung, an hour's drive outside of Seoul, Samsung Semiconductor & Telecommunications Company Ltd. is in the process of adding a new line for 1Mb and 4Mb DRAM chips. For the expansion, Kim Hyeon Gon, Samsung's managing director for strategic planning, promises, "Most of the equipment will be purchased from the U.S."

One area in which U.S. companies could excel is the market for machinery specifically tailored for producing semiconductors made of gallium arsenide (GaAs). This tiny market niche could reach significant proportions as many Korean chip makers begin dabbling with the new material.

Capital expenditures by Korean semiconductor companies



Goldstar Cable Co. is putting the finishing touches on its 3-inch wafer GaAs line. Last year, the company reinforced its development facilities with new, imported crystal-growing equipment.

Newcomers Kukje Corp., a subsidiary of Hanil, and Sammi have invested a combined total of more than $7 million to enter the GaAs market. Hanil, a leading maker of synthetic textiles in Korea, will commence with the production of GaAs light-emitting and laser diodes.

Furthermore, Korea's government is coordinating a project to develop a 4K SRAM GaAs chip by 1991. In addition, the government-run Electronics and Telecommunications Research Institute is heading up a research consortium to develop a 4Mb DRAM. The private sector participants include Goldstar, Hyundai and Samsung, which are collectively spending $64 million on research equipment.

> **"If we have a price war, we can't beat the Japanese"**
> **S.K. Suh, Varian**

One area of technology that has seen slow acceptance in Korea is that of surface mount. Indeed, a Korean trading agent estimates that the country imported only $10 million of surface mount equipment last year.

Executives at Samsung and Goldstar agree that their companies are still at least a year or two away from making a major push in surface mount technology. "We'll eventually look at SMT but I can't say when it'll happen," says Kim Jong Soon, a director in the semiconductor research division of Goldstar. Still, Daewoo Telecom says it will soon be making its personal computers — which are sold in the United States through Leading Edge Hardware Products Inc. of Canton, Mass. — using surface mount technology.

West Germany's push

The United States and Japan are not the only countries vying for a chunk of Korea's semiconductor infrastructure. West Germany's Hoechst has a stake in a $20 million photoresist and processing chemical plant in Korea that is due to start up this year.

And a few Korean companies — formerly based on now-waning industries like footwear, textiles and cement — are eagerly diversifying into the semiconductor materials and equipment market. Jeil Synthetic Textile Co., a Samsung Group subsidiary, recently invested $15 million to introduce photoresist manufacturing in Korea.

To counter the growing competition, some U.S. companies are attempting to strengthen their Korean beachhead by commencing manufacturing in the country. Last year, Macro LSI and E.I. du Pont de Nemours & Co. each entered into a separate joint venture to produce photomasks in Korea. Both companies' local partners had virtually no experience in electronics. □

[Editor's note: Dollar figures cited in this article were calculated at a conversion rate of $1 = 748 won]

Network management: Battle of the Network Stars

That's what it's like as AT&T, DEC, HP, IBM and Tandem, among others, vie for control of the corporate network and much, much more

BY PHILIP J. GILL

It might be called "Battle of the Network Stars," to steal a beat from a popular television game show. And a game it is, but not for the amusement of bleary-eyed contestants and television viewers. The network management game is being played for the benefit of the world's largest corporations, as well as for numerous medium- and small-sized firms. The prize: control of corporate computer and telecommunications networks.

On the surface, that might seem paltry, given the many billions of dollars in sales of computer systems sold every year by the leading contenders in network management. In comparison, *Fortune* 1,000 firms spent less than 1% of their total communications budgets on network management products and services, or about $500 million out of total expenditures of $51 billion in 1987, estimates Forrester Research Inc., a Cambridge, Mass., consulting firm.

But in the long run, network management will have a far-reaching impact not just on users and suppliers, but also on computer and communications equipment makers and the semiconductor and component manufacturers which supply them. The real prize is not so much sales of network management products and services — at least not until the market grows larger — but rather, sales of the systems and peripherals they will monitor. Indeed, during the last two to three years, network management has emerged as one of the key strategic battlegrounds for the industry's major computer and communications systems manufacturers.

"The strategic importance of network management is that if you do not have a very good or even superior network management offering, you're not going to be able to sell your computer systems," says Bernard Gudion, marketing manager for networking at Hewlett-Packard Co.'s Cupertino, California-based Information Networks Division. If they don't play the network management game, Gudion contends, vendors face a possible lock-out on lucrative commercial and government computer procurements.

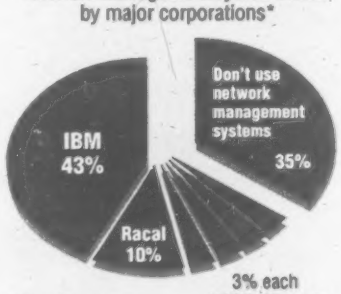
"It hasn't gotten to that point [yet]," counters David Korf, manager for network management marketing at Digital Equipment Corp. in Merrimack, N.H. "But it's certainly headed in that direction."

And then there's the fact that many a large market started out small. Early market leadership could well entrench key players, locking out opposition as the market grows in size and importance.

Increasing reliance on computers and networking within businesses will dramatically drive up the cost of network management goods and services between now and 1991, according to Forrester. In that year, network management expenditures will reach $2.8 billion, almost six times that of today's figures, although less than 4% of the total amount spent on communications.

Contenders in the network management systems market

Network management systems used by major corporations*



* Based on a survey of *Fortune* 1,000 companies

Source: Forrester Research Inc.

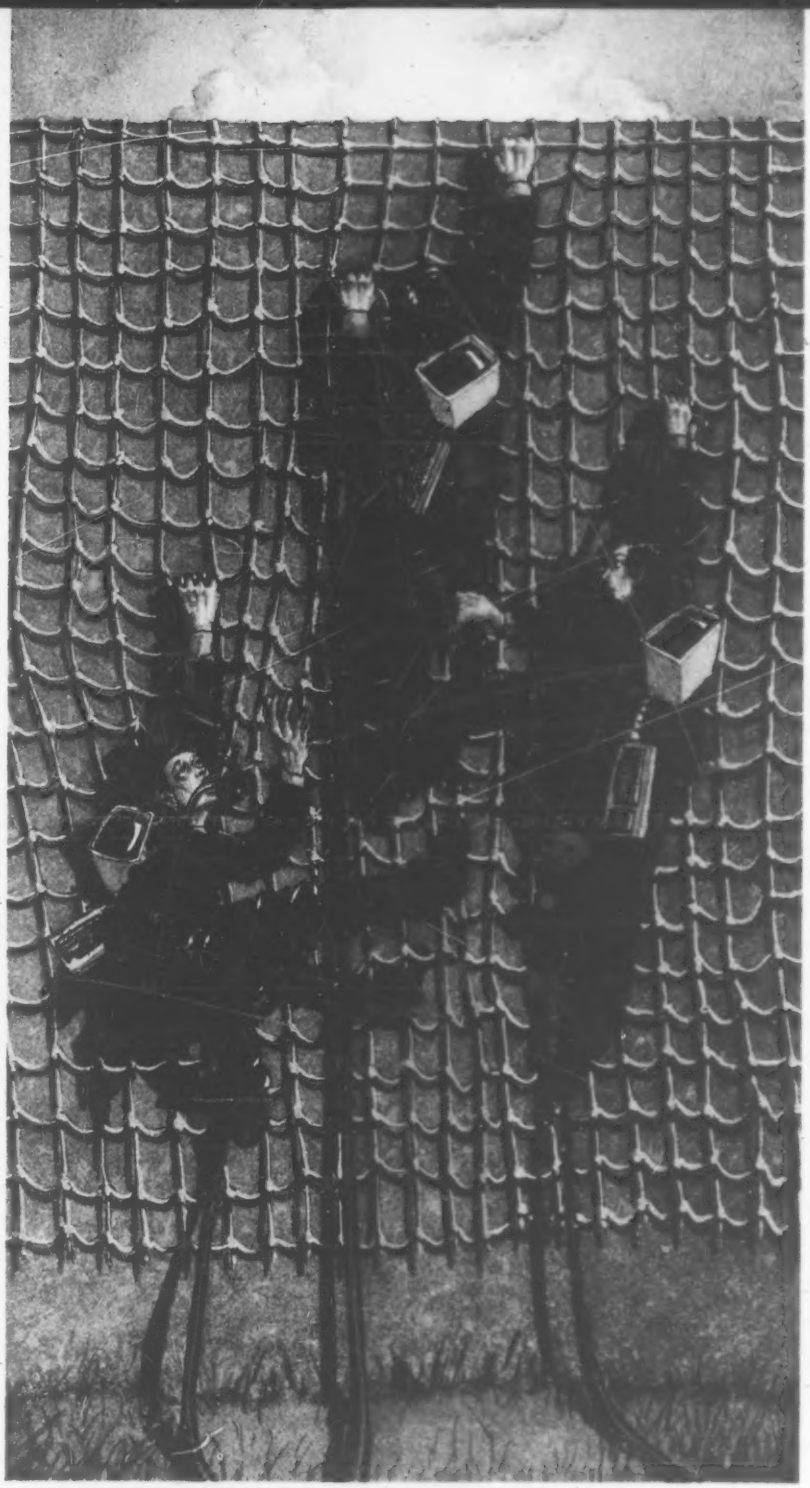
IBM's NetView has emerged as a de facto industry standard, primarily because of IBM's dominance in mainframes

Evolving networks

Network management isn't a new market, or even a new technology. Such functions and products have been essential components of corporate data processing since the beginning. But network management used to be far simpler, way back in the old days, when the all-powerful mainframe possessed all the processing power and intelligence. In those days, network management functions consisted largely of adding and deleting terminals, engaging and disengaging terminal cluster controllers, and other facilities that served the solitary host system.

In addition, every manufacturer offered its own network management system or services, usually proprietary in nature and capable of communicating only with the same type of equipment from the same manufacturer. "If you talk to any of these [vendors], they'll all say they have network management," says George Colony, president of Forrester. "The problem is that they don't work with each other's."

The era of multivendor computing environments, brought about by the proliferation of personal computers, word processors and other decentralized systems, brought with it the need for multivendor networking protocols and standards, such as the International Standards Organization's Open Systems Interconnect (ISO/OSI) Reference Model and the Manu-



facturing Automation Protocol/Technical Office Protocol (MAP/TOP). Not surprisingly, the need for multivendor network management systems and standards arrived shortly thereafter.

"Up until about four years ago, most network management systems were isolated, individual tools," explains John Mahr, senior product manager, Distributed Systems Management (DSM), at Tandem Computers Inc. in Cupertino, Calif. "Then there became an awareness that vendors needed to take a systematic approach to network management."

Technology and business forces also helped to highlight the need for more comprehensive network management systems. According to vendors and analysts, those forces include:

- Growth in the size of computer networks. Computer networks are growing much larger today, ranging into the tens of thousands of attached devices. In turn, managing, monitoring and detecting problems within those networks has grown much more complex.
- Networks have evolved from master/slave relationship frameworks, such as IBM's Systems Networking Architecture (SNA), to peer-to-peer links between distributed systems, such as minicomputers, departmental processors, workstations and above all, personal computers.
- A shortage of skilled personnel to man the network command center and manage the network.
- Increasing communication costs. Forrester forecasts that total communications expenditures in the crucial *Fortune* 1,000 marketplace will rise from $51 billion 1987 to $76 billion in 1991, a 50% increase.
- Computing and information systems have become strategic corporate resources. More companies depend on more computers and networks to keep their businesses running. Many companies, particularly in the fast-growing service sector industries, rely on their computers and networks to deliver revenue-producing goods and services to customers. The proliferation of bank automated teller machine networks, retail point of sale and other transaction processing system-based services attests to this.
- New technologies, such as T1 and Integrated Services Digital Network (ISDN), provide more data throughput across a single network line than previously available. While these increased network efficiencies will help hold down rising costs, they also serve to exacerbate the critical dependency of many companies on that network link.
- Finally, the breakup of the old Bell

Tom Barrett

System into AT&T and the regional Bell Operating Companies has opened up more long-distance and wide-area network connections.

The confluence of these forces has made network management a critical, strategic issue not just for vendors wanting to sell hardware, but for their customers as well. User frustration at the lack of network management tools from current suppliers might oblige them to run into the waiting arms of competitors.

"The need is so urgent that some of our customers can't wait," admits Tandem's Mahr. The first components of the company's DSM architecture, announced last fall, are already in selected customers' hands.

Vendors could feel the pinch in other ways as well. That frustration could have a ripple effect, Mahr and others warn, for if users can't grow their networks, they can't buy new systems. And because of the multivendor nature of networks, users are now demanding comprehensive network management systems that deliver a unified view of the network, and all the devices attached to it, from computers to modems and multiplexers and even applications residing on remote systems. "The first of those out the door was IBM's NetView," observes Tandem's Mahr.

HP's Bernard Gudion contends that vendors may not be able to sell systems if they don't offer superior network management systems

Dave Bradley

NetView has emerged as an undisputed de facto industry standard, primarily because of IBM's dominance of the mainframe world. NetView, which runs on IBM 370 and compatible mainframes, offers users a centralized, single point of view for IBM SNA networks. NetView/PC, a com-

The connectivity vendors: An overview

Four vendors are currently out in front as challengers to IBM's dominance of the network management marketplace. These firms hope to capitalize on IBM's weakness in the midrange systems marketplace, as well as on a growing user preference for open, industry-wide standards. These "connectivity vendors" include AT&T, Digital Equipment Corp., Hewlett-Packard Co., and Tandem Computers Inc. A brief overview of their respective network management offerings follows.

AT&T's UNMA

AT&T's offerings center on its Unified Network Management Architecture (UNMA), an umbrella architecture for a variety of network management products, services and open systems protocols that aim at providing integrated voice and data network management offerings. AT&T has pledged to base UNMA on the ISO/OSI reference model network management specifications, and to publish and license UNMA specifications to any interested parties.

UNMA is currently oriented toward managing the telephone line and customer premise equipment part of the networks, although AT&T's Bill Gilbert, division manager for network management planning at AT&T's Data Systems Division in Basking Ridge, N.J., claims that UNMA will eventually cover the spectrum of network management products and services.

"Our approach is intended to encompass a full range of network components, from end to end," Gilbert says. "It is not restricted to modems, multiplexers and lines." However, Gilbert adds that it is only natural that AT&T, a telecommunications giant, is "going to concentrate first on the management of those things we do best."

Tandem has published DSM specifications

Not surprisingly, UNMA has thus far gained the most support as an open industry standard from the ranks of datacommunications equipment suppliers, including DCA/Cohesive Inc., Dynatech Corp., General Datacomm Industries Inc., Integrated Telecom Corp., Newbridge Communications Corp. and Timeplex Inc.

HP's open view

HP's long-standing emphasis on standards carries over into its recently introduced Open View network management system. Open View, based on the ISO/OSI specifications, is designed to provide a comprehensive set of network management products and services to local area network and wide area environments outside the purview of IBM SNA networks.

The first release of Open View forms the foundation upon which the company will build future offerings. Currently, Open View offers systems management, performance management and a few other capabilities. Open View ties into IBM NetView through NetView/PC and uses HP Vectra PCs as network management workstations.

Perhaps its most distinguishing

plementary program that runs on IBM PCs, allows non-IBM SNA networks to participate in NetView network management functions by allowing reporting data into the IBM mainframe shop through a desktop IBM PC.

NetView/PC is as strategically important as NetView itself, because it solves the multivendor networking dilemma that has in large part created the current need for more advanced and sophisticated tools. Without NetView/PC or a similar product, IBM would have been justly accused of attempting to lock out non-IBM gear, a move widely viewed as unacceptable by most large corporate customers.

"IBM has held out an olive branch of multivendor networking to other vendors, and that is NetView/PC," says Forrester's Colony. And it's a branch most are grasping for. Even longtime network management specialists and IBM competitors such as Paradyne Corp., Largo, Fla., have come out with NetView and NetView/PC interfaces.

That, at least, is the image which IBM, a master of marketing spit and polish, projects for NetView. The reality is that although NetView addresses many customers' pressing needs for integrated network management tools, the product itself, at least in its earliest iterations, is little more than old IBM network management products, enhanced and repackaged.

By 1991, network management expenditures will reach $2.8 billion

Colony says that may account for IBM's claims of such a rapid convergence of the *Fortune* 1,000 on NetView as a standard. He says that Ellen Hancock, vice president and general manager of the IBM's Communications Systems Division, claims that 45% of the *Fortune* 1,000 companies have standardized on NetView. Colony believes that IBM counts users of Network Communications Control Facility and Network Problem Determination Authority products — the two old products upon which NetView is based — as "NetView users" as well.

Still, Colony says, "NetView is a raging success. It's a tidal wave that's going to take over network management."

The world against IBM

Others, while acknowledging IBM's importance and success with NetView, aren't quite so sure it's a tidal wave anywhere else but in the mainframe shop. "IBM is weakest in small- to medium-sized businesses that aren't dependent on an IBM mainframe," notes Clare Fleig, director of network management marketing at Hewlett-Packard Co., Palo Alto, Calif. "Our customers are looking for multivendor solutions."

HP's OpenView network management offering, announced in February, is a framework for integrating network management products from HP and other vendors. Its first application, LanProbe, is a software package that monitors and diagnoses problems on Ethernet LANs. Other applications, including a trouble-ticketing system, are planned.

OpenView's most distinctive feature, besides its ambitious positioning as an industry standard open to all, remains its graphically oriented, user interface based on the now-disputed Microsoft Corp. MS-Windows graphical interface and user operating environment. HP hopes that the interface as well as Open View offerings become part of the non-IBM world's network management standard.

Like AT&T, HP says it will publish and license Open View's specifications to all comers.

Tandem and DSM

Tandem's network management offerings are collectively dubbed Distributed Systems Management (DSM). DSM, also an umbrella, seeks to incorporate a full range of network management products and services — ranging from problem determination and error messaging — into the more sophisticated realms of remote systems management. A key feature of DSM is that, unlike NetView, it permits either centralized or decentralized network management functions, or a mix of both.

Currently, DSM manages only Tandem processors, although those processors can be connected through Tandem's proprietary Expand network, IBM SNA links, or X.25 public packet-switching networks. Tandem, not surprisingly, has positioned DSM as a "standard" for network management, and has published and released DSM specifications to others, particularly developers and suppliers of network equipment to Tandem network environments, so that they can conform their products to the DSM environment and protocols.

Digital remains the lone holdout

According to John Mahr, senior product manager of DSM, Tandem believes DSM will indeed become the standard for "mission critical" on-line transaction processing (OLTP) networks. Mission critical OLTP applications are those that deliver revenue-producing goods and services into the hands of customers, and include automated teller machines and retail point of sale networks, as well as factory automation and computer-integrated manufacturing application areas.

DEC and DECnet

DEC remains the lone holdout among the emerging ranks of connectivity vendors in not having an umbrella name and architecture for its DECnet network management. Nevertheless, DEC has extensive network management offerings for its widely installed DECnet products, offered as embedded DECnet products, layered products and custom services, according to David Kopf, DEC's manager for network management marketing.

DEC, he says, plans to leverage recently relabeled DECnet/OSI to signify its adherence to the ISO/OSI protocols and its status as open architecture with specifications available to others.

Analysts say the company has been briefing them, as well as customers, on a forthcoming network management offering similar to IBM's NetView and NetView/PC. A drawback, according to one analyst, is that DEC's NetView equivalent will be decentralized, as opposed to IBM's centralized version.

AT&T's William Gilbert: "OSI will provide a better and more comprehensive set of management tools for non-SNA resources"

tor of systems research at market analyst International Technology Group Inc., Los Altos, Calif. Other analysts go one step further, claiming IBM is not only weak, but vulnerable in that arena.

IBM's past sins keep coming back to haunt it, like bad dreams and old witches' curses. Despite its best efforts, IBM's midrange product line has been its most confused, scattered, and in the end, disappointing, line. That creates significant opportunities for vendors who lead the market in that area to penetrate what otherwise might be all Big Blue accounts.

George Weiss, program director for midrange systems at the Gartner Group Inc., in Stamford, Conn., says that a new class of three or four "connectivity vendors" is emerging from the ranks of the midrange systems manufacturers. These connectivity vendors, he says, will attempt to complement, rather than compete with IBM's NetView. They will also play a crucial role in connecting IBM's mainframe-based SNA networks with the rest of the corporation.

Most SNA networks don't extend their network management reach throughout the entire corporation. For instance, many companies have subnetworks of PCs in departments and factories that support other protocols. To bring these non-IBM SNA networks into the fold, IBM holds out NetView/PC. But competitors and critics charge that the NetView/PC doesn't measure up to what they can offer, or even to the standard NetView offering.

"IBM does a good job in managing IBM equipment in an SNA network," says HP's Gudion, "but not for non-IBM systems in a non-SNA network."

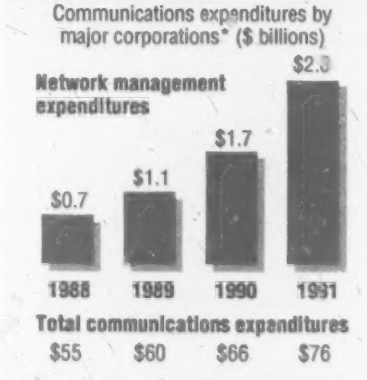
SNA has architectural limitations that NetView's competitors are bound to play on as well. "NetView may do well in [today's] SNA environment," notes DEC's Kopf, "but if you look out five years from now, to the confluence of voice, data and graphics across the same network, SNA just won't be able to handle that."

IBM's competitors are also playing the standards game. For the most part, those emerging connectivity vendors, whose ranks currently include AT&T, DEC, HP, and Tandem, are rallying around the network management components of the ISO/OSI Reference Model.

"OSI will provide a better and more comprehensive set of management tools for non-SNA resources," predicts William Gilbert, division manager, network management planning, for AT&T's Data Systems Division in Basking Ridge, N.J.

Still, there's one other factor that could play into the hands of IBM's network management competitors as well. If Big Blue doesn't deliver on time and as promised, "they could blow it," says Forrester's Colony.

Corporate spending for network management systems



Although small in comparison with total communications budgets, spending on network management systems will quadruple by 1991

A long way to go

All this leaves vendors with a long way to go in a short amount of time. Most expect the dust of a supercharged network management market to settle down to IBM and three to five important others over the next few years. Even then, it seems doubtful that customers will get that "single, unified" view from a comprehensive network management system they say they want.

"Over the next five years, our major customers will get their networks down to three, maybe four network management systems, with some degree of interaction between them," predicts Tandem's Mahr.

Anything beyond three or four interlocking network management systems might well have to wait for OSI network management protocols to solidify. Five years out should be just about the right time, some say. OSI will, by that time, form the basis for viable network management products, turning network management systems, like so much else, into a commodity-like product. Gartner's Weiss says that vendors will then have to try to outmaneuver each other by touting their particular value-added products such as languages, advanced computer-aided software engineering tools and user interfaces.

In the meantime, IBM's competition had best move quickly to hone their skills and deliver products in what may be prove to a crucial, make-or-break product offering area. From all reports, users will be taking sides and picking winners very soon.

Jeffrey Vock

CAE software: Still bundled after all these years

Analysts insist that CAE companies must get out of hardware reselling. Some vendors and customers like bundling too much to agree. Here's why

BY DAVID CARD

Listening to some industry observers, you might think CAE leader Mentor Graphics Corp. is in trouble. Funny how that doesn't seem to be the case. Mentor is coming off a record-setting year in sales — $221.8 million, and profits — $20.3 million, placing fifth on the ELECTRONIC BUSINESS list of fastest growing electronics companies. One of the key reasons why Mentor is twice the size of its nearest competitor is that it sells the computers which run its software.

Yet market researchers and Wall Street analysts have been saying for several years now that computer-aided engineering companies ought to get out of the hardware business. Time and again they bring up the example of the broader CAD/CAM industry where Computervision Corp. struggled for years to stop making its own computers. Similarly, in CAE, Mentor arch rival Daisy Systems Corp. — No. 15 on the fast-growth hit parade — is completing a difficult transition away from building its own workstations.

But all three still *sell* hardware with a vengeance; it's just that it's somebody else's hardware. Plus, some CAE software-only companies, including Case Technology and Teradyne Inc.'s CAE division, have recently added hardware to their catalogs. Two of the reasons are basic: CAE vendors say they can mark up profit on the hardware they resell, and many big CAE customers still want one-stop shopping.

That's not to say that long-term, the trend toward "unbundling" software from hardware won't continue. Andrew Rappaport, president of Boston consultancy The Technology Research Group, forecasts that by 1990, less than 40% of the workstations sold into CAE will be sold "turnkey," in bundled systems. That's down from 100% in 1983 and over 70% last year. He adds that CAE vendors slow to adapt will suffer from competitors who go software-only. "Mentor's biggest challenge is that the structure of the industry is changing out from under them," he says.

So if CAE players like Mentor are still pro-bundling, what keeps the unbundling trend rolling on? It's partly fueled by the CAE up-and-comers like Viewlogic Systems Inc. and ECAD Inc., which are strictly software-only and have focused on writing packages that can be ported onto different workstations.

Researcher Rappaport thinks Mentor needs to unbundle but doesn't want to. Take away the 40% of Mentor's sales that he estimates is hardware — Mentor has always resold workstations from Apollo Computer Inc. — and Mentor would "become a much smaller company in a hurry," he says. Plus, Rappaport concludes, Mentor would lose a lot of account control.

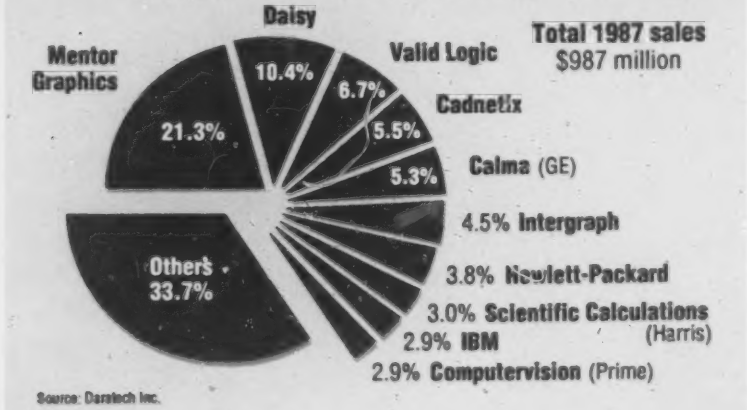
Maximum profits

Others put Mentor's hardware slice of revenue even higher: according to David Korus, a researcher with investment brokerage Kidder, Peabody & Co., it's as much as 55%. He doesn't like that. He and other Wall Street analysts want maximum profits when they demand for Mentor et al that "the Autodesk model is the model these companies have to follow." Autodesk Inc., the PC-based CAD leader, sells its drafting software through dealers. Korus can envision a day when CAE will go through dealers too — in imagining a "Chips R Us" store, he's only half-joking. By not selling hardware, and with a minimal salesforce, Autodesk keeps its gross margins above 80%.

Korus thinks CAE companies selling hardware are too hooked on the

Top U.S. electronics CAE/CAD suppliers

Share of 1987 worldwide sales by U.S. vendors



Source: Dataquest Inc.

idea of becoming *big* companies. "You don't want to give up 55% of your revenue," Korus says of Mentor management, "because you can't drive a Ferrari as easily."

Mentor president Gerard Langeler has a ready reply to that: he claims he needs a big top line to keep up his R&D spending. "Folks who go software-only tend to be niche players," he says. The Autodesk analogy is singularly inappropriate for CAE, Langeler says, because there are millions of potential drafting customers, compared with only 400,000 electrical engineers in the world. "Our applications are much more complex," he says, "and they need a lot more handholding." And anyway, Mentor's gross margins on systems are above 50% — "adequate, finally," for the demanding Langeler.

Mentor does offer software-only, but discourages customers by jacking up the price. As Apollo's largest OEM, Mentor commands nice discounts on Apollo workstations. Thus, looking at Mentor's price list, the computers seem very cheap — unbundled software commands a 20%-plus premium, Langeler says. He even picks up the profitable service business for the workstations.

Likewise, No. 2 CAE player Daisy still makes money off of computers, according to president Norman Friedmann. "A substantial part of the profitability is still in hardware," he says. "Bars sold drinks and gave away cigarettes. It ain't quite that way in this business." He adds: "I have not perceived a mad rush on the part of our customers to demand unbundling. We're prepared to do it [if necessary]."

Another company that, like Daisy, is making the switch from proprietary workstations, Cadnetix Corp., also continues to sell hardware. Cadnetix has moved onto a combination of PCs and Sun Microsystems Inc. workstations, yet reports 95% of its sales as turnkey, according to marketing vice president O.B. "Buck" Feltman. Cadnetix is a Wall Street favorite just as Mentor is, and has a similar attitude toward the stock peddlers.

Volume discounts

When the industry observers say that unbundling is the way to go, their theory is that big customers will cut volume discount arrangements with the workstation companies that will make the hardware cheaper for them than the CAE companies' discounts.

By that reasoning, Eastman Kodak Co. should be the archetypal Big Company CAE customer. Kodak was an original sponsor of Sun, is a Sun OEM, and even owns equity in the company. Yet Kodak buys the Sun workstations it uses for CAE from Case Technology, a CAE company that until recently was software-only.

Kodak senior project engineer Michael Cosgrove says he wants to be able to depreciate the CAE set-up as a system, instead of as hardware and software separately. The cost of overhead — including support and depreciation — is more important than the initial purchase cost, he says. Case charges a premium over the Sun list price.

Cosgrove admits that Kodak has software and maintenance deals with Digital Equipment Corp. that are tighter than the ones with Sun. And Case software runs on DEC hardware as well. But Cosgrove says he was willing to ignore the DEC ties — "DEC is bearing on us" about it, he says — because, he claims, the software simply runs better on Sun.

Westinghouse Electric Corp. qualifies as another such big customer, with over 50 CAE systems from Tektronix Inc., and half again as many from Mentor — all on Apollo workstations. (Mentor, partly to tie in customers like Westinghouse, recently bought out Tek's CAE business.) Yet Westinghouse also chooses to buy the computers from the CAE companies, according to John DeCaire, general manager of Westinghouse's Design and Producibility Engineering Division. Mentor "burns-in" the software on the hardware, which means "it works when it arrives," DeCaire says. Plus, buying systems from one source "avoids any finger-pointing about: What's the problem? and: Who's responsible?"

The fact that Kodak and also

Doreen Gay-Kassel

Xerox Corp. were willing to pay a premium for one-stop shopping is what convinced Case Technology to sell hardware, says president Kevin Kerns. "That's what answered my questions about turnkeying hardware," he says. He resells a maintenance contract, and Sun often ships the workstations directly to the end user so Case doesn't have to absorb the inventory costs. Kerns expects 25% of Case's sales this year to be bundled.

Other converts

Teradyne, Case's new parent, has a similar story, although both companies say their strategies developed independently. Less than 5% of Teradyne's CAE sales were bundled until now. Teradyne is best known as an automatic test equipment company, but it sells a CAE simulator that usually runs on DEC minicomputers. Now Teradyne is bundling DEC workstations with its simulator, a set-up that Teradyne CAE general manager Jeff Hotchkiss expects will meet 90% of his customers' requirements.

DEC is encouraging such arrangements for what it considers the low end of its product line, Hotchkiss says. Discounts for resellers are at par with those offered to volume end-users. That allows Teradyne to mark up hardware prices by 5% to 10%. Hotchkiss figures the bundled business will be pure gravy to Teradyne sales, so even the small margin goes straight to the bottom line. He adds another bonus: DEC competitors — many of which are Teradyne customers — don't mind buying a DEC hardware/Teradyne software combination as much as they might object to dealing directly with DEC.

"A substantial part of the profitability is still in hardware"
Norman Friedmann, Daisy

Even IBM, which has arguably the best third-party distribution channel going, sells CAE turnkey. IBM approaches things from the opposite direction compared with most CAE companies — it makes the hardware and resells somebody else's software. IBM's director of CAE marketing, Robert Tiel, finds Korus's "Chips R Us" concept "highly remote." He says: "We think dealers don't have what it takes. The guys we have selling simulation have master's degrees, and they're intimidated by the customers with Ph.D.s."

Although there are plenty of voices still in favor of bundling, analysts insist the underlying trend toward unbundling remains, for many other reasons. CAE buyers such as NASA, though they don't go to retailers, like to buy their hardware from computer companies. NASA's Langley Research Center bought CAE software from Case, but it bought the hardware on its own from DEC and PC clone makers.

One NASA engineer and CAE user, Randy Regan, explains that Langeley qualifies for DEC's government discount rate of 20% to 30%. Plus, it has many DEC computers already, and needed only additional software. But the kicker, Regan says, was that government purchases over $25,000 have to be advertised, adding another 30 days to the buying cycle. By separating the hardware and software purchasing, Reagan says, he can avoid the extra step and speed up the order. □

Creative software pricing 101

In the midst of the turnkey/unbundling debate, up pops another software issue to confuse CAE vendors. "People are starting to look at creative ways to price software," says Andrew Rappaport, president of The Technology Research Group. "There will be more demand to do what Valid is doing."

What Valid Logic Systems Inc. is doing seems almost a throwback to the days of the host computer. CAE companies in large part launched distributed computing with workstations, and have charged for software on a per-seat basis. One workstation, one set of CAE software; two workstations, two sets. But Valid's "Access" pricing scheme holds that customers don't have to pay for applications that aren't needed by every design engineer every minute.

Access is a network-brokerage licensing arrangement where a number of copies reside on a server, with "keys" at any given workstation. Engineers "check out" the software they need; if all the copies are out, they have to wait. Valid may make less selling fewer CAE packages, but it charges for the workstation keys — and hopes to "seed" a broader customer base.

Valid's strategy seems almost a throwback to the days of the host computer

Competitor Mentor Graphics Corp. is leery of Valid's strategy. "Network licensing at its extreme is site licensing," says Mentor president Gerard Langeler, "and there are ample indications that people who site-license don't stay in business." Customers who license software for a one-time corporate fee often don't come back for more, Langeler says.

Valid president W. Douglas Hajjar admits that it is too early to tell if his profits are going to suffer from his new pricing. But he disagrees that customers won't come back. Once engineers are addicted to his software, he says, "they're going to want the software without waiting in line. It's back to the old host problem." That's when Valid will sell more packages.

Tom Chai, CAD and ASIC general manager for Wyse Technology, says using Valid's new program saved as much as 50% on software costs. Chai is "trying to push it to other vendors," he says. Mentor customer Westinghouse Electric has heard of Valid's system, and appears appreciative. "We're looking forward to being able to do that," says a Westinghouse general manager, John DeCaire. □

CAD/CAM after Computervision: Will anything really change?

As Prime Computer figures out how to manage its CV acquisition, rivals see opportunity. There could be strategic shifts for hardware suppliers, too

BY DAVID CARD

The hostile takeover is done, but, as usual, the real battle is just beginning. Prime Computer Inc.'s $435 million acquisition of Computervision Corp. in January means there is a new No. 2 in computer-aided design and manufacturing.

On its own, Prime held just 3.6% of the $4.6 billion CAD/CAM equipment market last year. But this year, it will boast a 16% slice of a market that will be worth $5.2 billion, forecasts Daratech Inc. The Cambridge, Massachusetts-based researcher expects the market to grow at about 10% annually through the 1990s.

But Prime's second-place crown is a paper one unless Prime can hold off competitors that see a chance to pick off contracts. "It's not like we're sharks circling the bait," says Michael Smith, a marketing director at competitor Schlumberger/Applicon. "But it *is* a competitive market."

Prime's new CAD/CAM stance will also color already complex relationships with hardware suppliers, such as those with Digital Equipment Corp. and Sun Microsystems Inc.

Newly displaced Intergraph Corp. is watching the old fear, uncertainty and doubt factor. "There's a lot of FUD right now that we could take advantage of," says Intergraph vice president Robert Glasier.

However, Marvin Kirby, Prime's vice president for CAD/CAM marketing, which includes Computervision, isn't worried. Kirby sees "no negative effects in terms of business" since the merger. Orders for both product lines "are about as forecast," Kirby says. And he remains noncommittal about how long it will take to get things working smoothly. "Over time, where it makes sense," Kirby says, "we will tie the [Prime and CV] functions together. We will not force anyone to do it where they don't want to."

But does this mean meshing of product lines? Natick, Massachusetts-based Prime is, of course, a minicomputer maker, although it is flexible in its CAD/CAM business. Prime resells Sun workstations as midrange machines, and Silicon Graphics Inc. high-end workstations, along with its minis. According to David Burdick, an analyst at San Jose market researcher Dataquest Inc., Prime claims there is "a synergy in the product lines" between it and its Bedford, Mass., neighbor Computervision. "We don't buy that," Burdick says.

But the Dataquest researcher sees the merger as a good way to gain share in a maturing market. If it does work out, he maintains that it's a major threat to the "larger turnkey companies that offer end-to-end solutions," like IBM and Intergraph. Daratech president Charles Foundyller agrees, but adds that the PC CAD leader, Autodesk Inc., might feel the heat from the combo: "For the first time somebody has a shot at at least slowing Autodesk down."

Dave Bradley

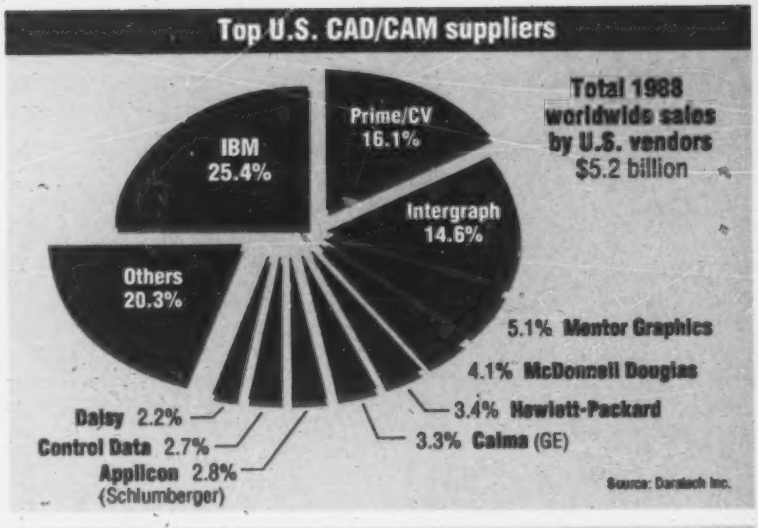
Prime's CAD/CAM chief, Marvin Kirby, says customers are willing to give Prime the time it needs

Emphasis on execution

Daratech's Foundyller likes Prime's long-term prospects a lot better than premerger Computervision's. "Prime has a long-term play," he says, "now it's execution. There are still many ways to screw up."

Prime bought another CAD company last year, VersaCAD Corp., that sells software for personal computers. Prime is "integrating VersaCAD with a surgeon's hand," says VersaCAD president Tom Lazear. "Often mergers are done with meat hooks and clubs and something gets ruined."

Not surprisingly, competitors are



Prime's acquisition plus its own fast growth equals No. 2 in CAD/CAM

less bullish on the link-up. No. 4 in CAD/CAM — and No. 1 in the market's electronics segment — is Mentor Graphics Corp. Mentor president Gerard Langeler says the immediate effect of the acquisition has been to "put a lot of good resumes on the street." A handful of top CV executives, including president Robert Gable, has left.

"In the history of the CAD/CAM business, there has never, ever been a merger that worked well," charges Mentor's Langeler. "CV wasn't nearly as healthy as Calma and Applicon when they were purchased." Applicon has indeed lost market share fairly steadily since its acquisition by Schlumberger Ltd., as has Calma since General Electric Co. stepped in, according to Daratech.

CV helped invent CAD/CAM, and used to own the market. As late as 1984, CV was still No. 1, but its market share had halved from 30% in the late '70s. It wasn't so much CV shrinking as IBM and Intergraph growing, although the company had tough times recently, losing a total of nearly $90 million in 1985 and 1986. Foundyller and others attribute much of CV's decline to its reliance on homemade minicomputers, as the industry shifted to computers from workstation companies, IBM and DEC. But CV had turned its balance sheet positive, and switched to workstations from Sun [ELECTRONIC BUSINESS April 1, 1987 p51] when Prime made its offer.

Meanwhile, Prime's big turnkey rivals are not waiting around. Dassault Systems USA is the U.S. marketing arm of the French aerospace company that makes CAD/CAM software which IBM resells. Dassault Systems USA president Joan Hoeberichts has her eye on the CV customer base: "We're certainly courting them. The confusion in the organization is not working in their favor in the marketplace." She's looking at Prime customers, too: "The only place Prime is a real force at all is at Ford. We've already been there."

At Ford, integration is Job 1

Well, if Dassault/IBM is calling on Ford Motor Co., Ford has not been listening too hard. Bill Powers, director of production and manufacturing systems for Ford's North American Automotive operations, says he has not seen the "hard sell" from other CAD/CAM companies since the merger, but he admits that may be because Ford is the most loyal of Prime and CV customers. He claims Ford is Prime's largest CAD/CAM customer and CV's largest non-government user.

As probably the only customer with a large CV *and* Prime base, Ford was particularly undisturbed by the merger. Says Powers: "Basically, we have always had good communications with both companies. Now that they are together, it even helps with some of our internal problems." Especially in integrating the two: for instance, making the automotive power train systems that are designed on CV equipment fit into the body work done on Prime CAD. (Actually, the Prime CAD system that Ford uses is not off the shelf; it was codeveloped by Prime and Ford.)

One twist to the Prime/CV deal is the relationship with DEC. Besides its sourcing from Sun, Computervision sells a little DEC hardware, mostly in Europe. Applicon's Smith sees openings there and in the United States for Applicon, which sells DEC computers and workstations as well as Sun's. Computervision was a DEC strategic cooperative marketing partner (SCMP), but Smith doesn't think that will last: "I would think they would withdraw."

Prime's Kirby has a quick answer for that: "The relationship with DEC has not changed. Other people are saying: 'Hey, they're going to make you go with a Prime platform.' " That's not true, he says. But he does admit the SCMP status is a little uncertain. "We're proceeding to try and hammer that one out," he says.

If the DEC ties are being strained, the Sun connections are firming. Prime CAD/CAM president Robert Fischer told ELECTRONIC BUSINESS last year that the margins he would make reselling Sun workstations were pretty thin. But CV was one of Sun's first OEMs, and was thus able to cut a manufacturing arrangement with the young company. The "technology, manufacturing, and OEM agreements [with Sun] apply across the entire corporation," Kirby explains. That is, Prime can now buy board-level computers from Sun under the CV deal, adding meat to its margins. Would Prime consider moving Sun workstations aggressively into its other computer markets? "As we see the opportunity to do it, you could expect us to do it," concedes Kirby.

The acquisition should unite some software as well. CV owns Cambridge Interactive Systems Ltd., the British company that wrote the original "Medusa" mechanical CAD software that both CV and Prime sell. CV sold more Medusa in Europe than in the United States, according to Kirby, so the overlap is complementary rather than competitive.

But in April Prime brought out a new version of Medusa-compatible software for its Silicon Graphics workstations. "That surprises me," says Dataquest's Burdick. "That just adds another bit of confusion — whether it's going to be a trench battle between the two companies over who has the best CAD/CAM product." □

Back to basics for growth: RISC microprocessors

RISC is to computers what the stick shift is to hot rodders. It also may make money for chip makers

Hot rodders waiting for a red light to turn green know very well that, engine sizes being equal, a skillful hand at a stick shift can outperform even the best automatic transmission. Their skill is needed to translate their objective — to accelerate from zero to cruising speed in minimum time — into steps that their clutch, gearbox and engine can take without buckling under the strain. By contrast, the more complex automatic transmission will pick up speed in the correct sequence every time, regardless of the driver's skill, but at the expense of acceleration, acquisition cost and fuel efficiency.

Same with microprocessors. Looking to run more mega-instructions per second (MIPS) in their computers, hot bit logic designers today are turning to microprocessors based on reduced instruction set computing architecture. Like manual transmissions, RISC microprocessors carry fewer, more elementary instructions than the currently popular CISC, or complex instruction set computing micros. Like automatic transmissions, CISC's elaborate instructions make it easier to specify functions (such as direct memory access), but do so at MIPS' expense because they require an internal microprogram to decode the complex instructions into elementary logic.

Add to that the increasing size and density of modern chips, and you see why RISC has put a MIPS gleam in chip makers' eyes. From comparisons with Digital Equipment Corp.'s VAX less than two years ago, their talk has climbed now into the MIPS range of Cray Research Inc.'s supercomputers.

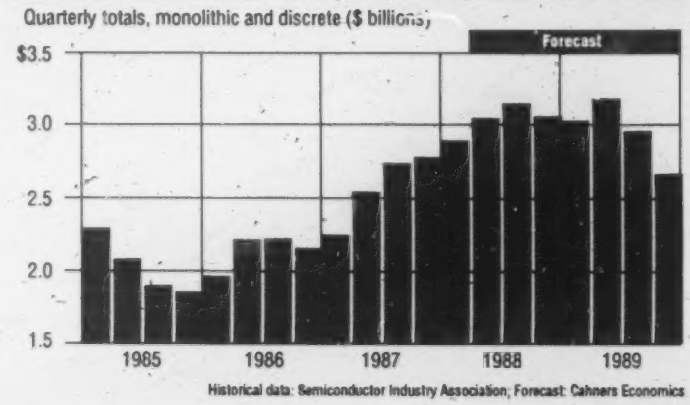
Jack Beedle sees RISC as the next growth market for semiconductors. The president of market researcher In-Stat Inc. counts only five chip makers who are making RISC microprocessors today: Intel Corp., Intergraph Corp., MIPS Computer Systems Inc., Motorola Inc. and Sun Microsystems Inc.

High-power microprocessors look like the next fertile ground where the seeds for new companies are being sown. Worldwide sales of their CMOS versions, used primarily for the faster and more complex models, more than tripled (in dollars) in the first quarter of 1988, with respect to the same quarter of last year. Unit growth contributed only one-third of the increase. The rest of that increase resulted from a doubling in prices, up from an average of $10 to $20 per unit. While there are shortages of Intel's highly popular 32-bit 80386, most of the price climb derives from a change in mix from 16- to 32-bit processors.

Such is not the case in memories. "The market [for 256K DRAMs] has almost $1 billion that can evaporate when prices come down," says Daniel Queyssac, president and CEO of SGS-Thomson Microelectronics Inc. This may happen by the end of 1988, when most observers predict that worldwide production of memory chips will catch up with the demand. Still, by then the U.S. market for ICs will have grown by 24% over 1987, to more than $10 billion, forecasts Cahners senior economist Elizabeth Baatz. She foresees another 20% growth in 1989. So, even if the billion-dollar memories do evaporate, there will be plenty of dollars worth of microprocessors, both conventional CISC and MIPS-powerful RISC, to take up that slack.

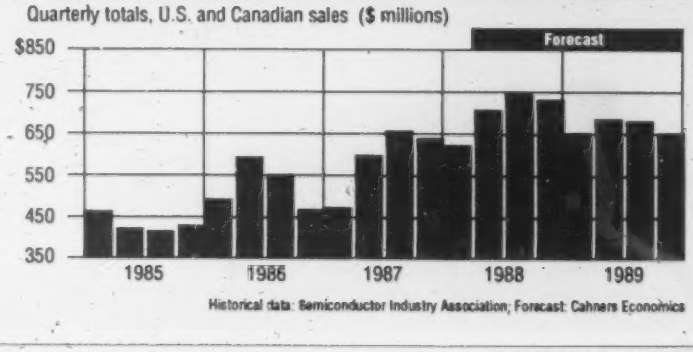
ALBERTO SOCOLOVSKY

U.S. semiconductor sales



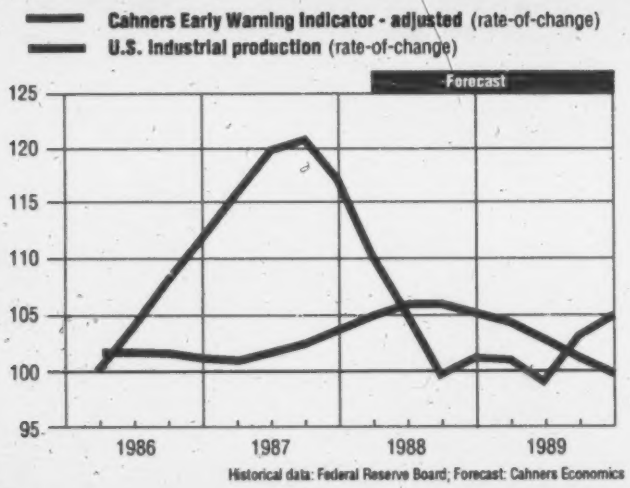
Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

U.S. semiconductor distributor sales



Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

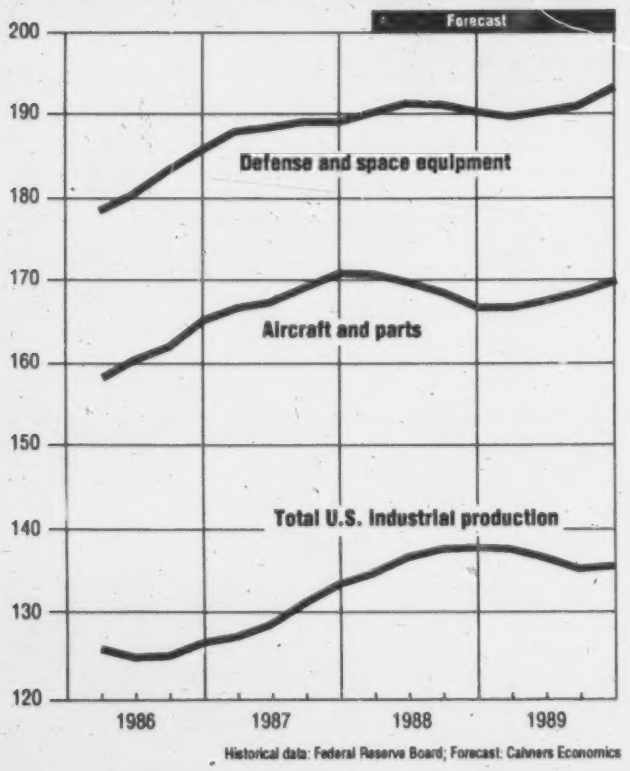
U.S. economic indicators



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Defense equipment — Industrial production

Quarterly averages, 1977 = 100, seasonally adjusted



Historical data: Federal Reserve Board; Forecast: Cahners Economics

U.S. exports and business investment fuel growth

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according to the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

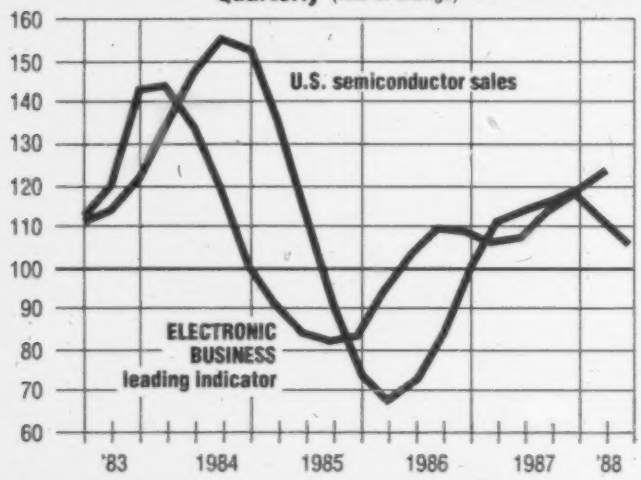
Defense and aircraft production holding

Factory production in the United States for defense and space equipment rose 0.5% in the first quarter of 1988 and is headed for a 1% annual gain this year. The Congressional Budget Office projects average growth of national defense outlays of only 2.8% over the next three years. While the Department of Defense budget actually will be falling in inflation-adjusted dollars, the Electronic Industries Association projects spending on the electronic content to increase to around 40% this year, up from 37% in 1986. The focus now is on modernization and cost effectiveness. Companies involved with space electronics, training and simulation, command, control, communications and intelligence (C^3I) will weather the constricting defense budget the best.

The aircraft industry faltered in early 1988 as production fell 0.3% in the first quarter of this year. Cahners Economics forecast that U.S. factory output of aircraft will be neither growing nor falling significantly over the next two years. Production of a number of military initiatives, such as the B-1B bomber and C-5B cargo plane, are winding down. Although some aircraft procurement programs will be stretched out, development of several others may be delayed or dropped altogether.

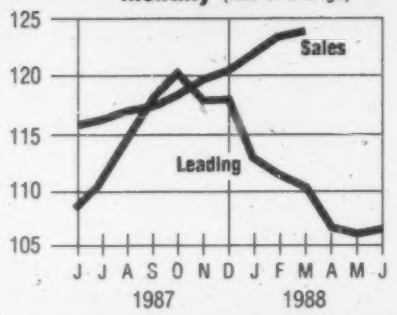
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton Mass. 02158 or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS indicator fell to 111.5 in February from 112.9 in January. This was the fourth consecutive monthly decline. The indicator is estimated to fall to the 106-107 level in June, back to its early 1987 level. What does it mean? U.S. semiconductor sales will likely peak this summer, but the downturn this fall will be relatively mild.

Source: Cahners Economics

Electronic industry indicators this month

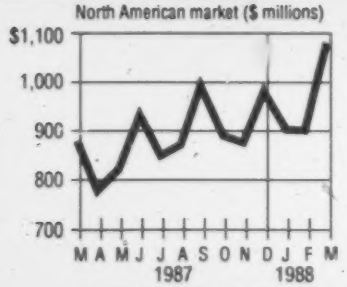
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Feb.)	111.5	112.9	105.6	111.8
U.S. semiconductor bookings ($ millions, 3-month average, March)	$1,126	$1,080	$912	$951
Weekly hours of semiconductor production workers (monthly average, Feb.)	40.1	40.4	40.6	40.6
Electronic components leadtime index (1977 = 100, April)	105.2	106.8	105.7	100.7
Standard & Poor's semiconductor price index (1970 =10, monthly average, March)	59.2	52.9	63.6	65.5
Change in electronic components inventories ($ millions, SA, March)	+$52	+$142	-$36	+$46
Contract and orders for plant and equipment ($ billions, SA, March)	$37.8	$38.8	$32.8	$34.4

SA = seasonally adjusted; all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

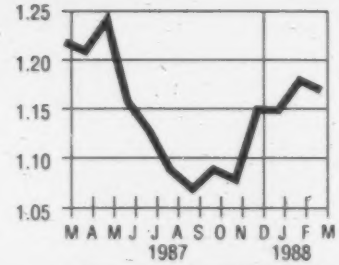
Semiconductor sales

North American market ($ millions)



Source: Semiconductor Industry Association

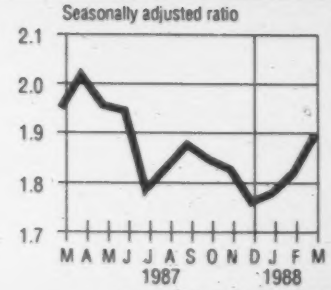
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JUNE 15, 1988

DARE TO BE DULL

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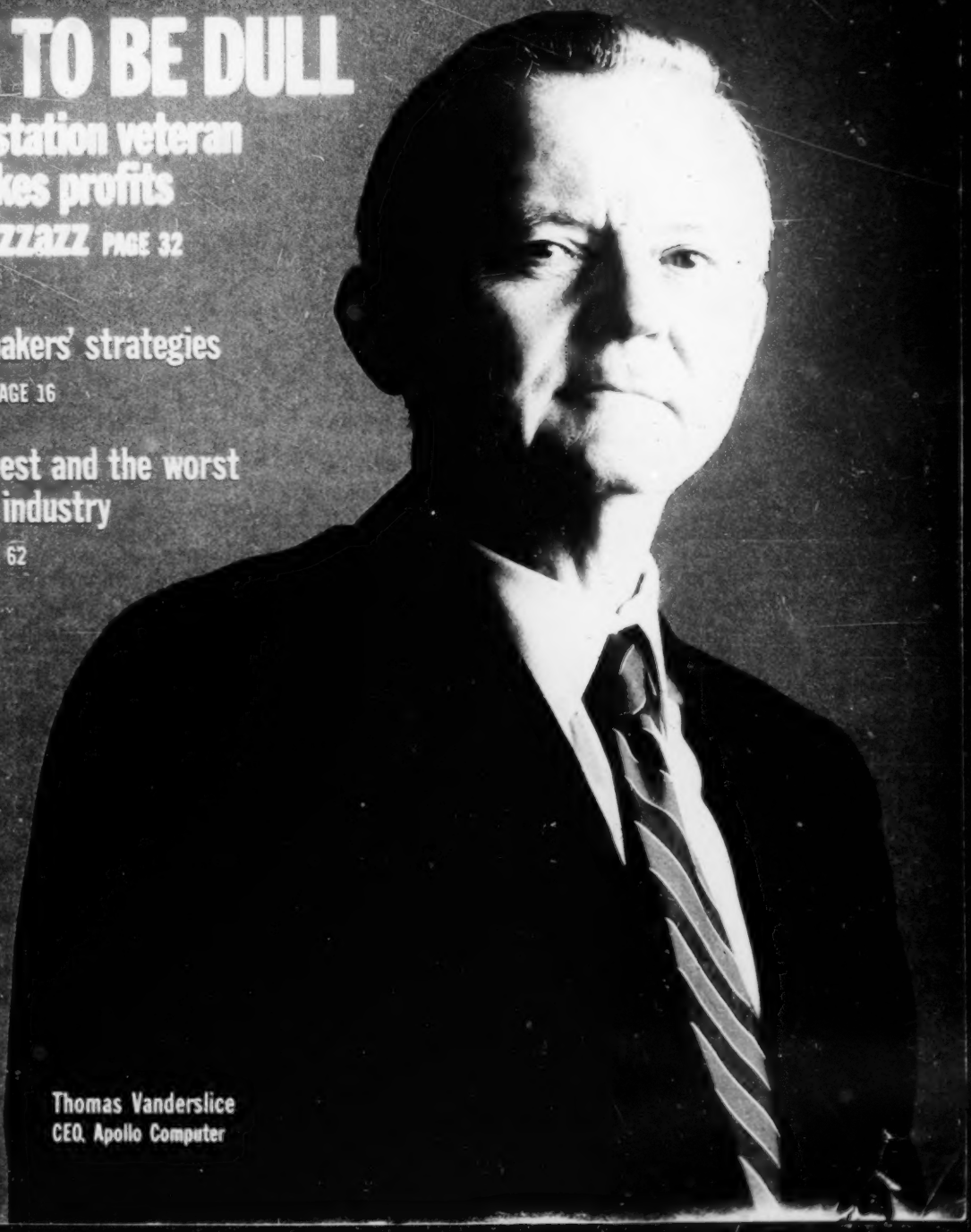
Small chip makers' strategies for Europe PAGE 16

Rating the best and the worst electronics-industry mergers PAGE 62



Thomas Vanderslice
CEO, Apollo Computer

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES WORLDWIDE

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Pass the pizzazz, please

As our cover plainly states, Apollo Computer chairman Tom Vanderslice has a probiem. Apollo is as bold and brash as any start-up computer company that's come along in the past five years. But possibly because Tom, a GTE veteran, is a low-key kind of guy, the firm never gets as much press coverage as its West Coast workstation rival and market leader, Sun Microsystems.

To rectify that situation, we asked associate editor Beth Karlin to visit Apollo. The company is doing just fine, thank you, we learned. But it still has an image problem to overcome. More often than not, the word "stodgy" is the one that comes to mind.

Take our cover photo. When we asked the chairman, who is a jogger of sorts, if he wouldn't mind being photographed in the company gym, he respectfully declined. He didn't give us any reasons for turning down our suggestion — it's not because he's not in shape, because he is —but we suspect that chairman Vanderslice has an image of himself and his company, and that image doesn't involve sweatbands.

So be it. Business is won or lost in the marketplace, not on a Nautilus machine. But in an industry where image is, if not everything, at least 90% of everything, it sometimes pays to be a little daring.

Vanderslice: This is as hip as we get

That's our opinion anyway. In any event, dull or not, Apollo — at $550 million in sales last year — is a force to be reckoned with in the workstation arena. We highly recommend our story.

AL FURST

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VBPA ABP

SMT snapshot: U.S. electronics assembly lags

Since 1983, first-pass yields in U.S. electronics assembly are up 10% and leadtimes have halved. But there's a ways to go

BY CHARLES-HENRI MANGIN

Charles-Henri Mangin is president of Ceeris International Inc., a consulting firm in Old Lyme, Conn., which specializes in electronics assembly. Ceeris has been monitoring assembly performance in the United States since 1983

Based on our recent detailed analysis of 50 large electronic factories in the United States, which collectively assemble approximately 15% of the boards in this country, we can conclude that the U.S. electronics assembly industry still has a ways to go before it catches up with foreign operations. Our analysis focused on management issues such as:

- assembly resources utilization,
- level of work-in-process,
- first-pass yields,
- cost of assembly,
- leadtime for assembly,
- introduction of surface mount designs, and
- new design introduction rate.

The 50 assembly lines we studied assembled a total of 73.3 million boards per year and 11.5 billion components, of which 36% were surface mount components.

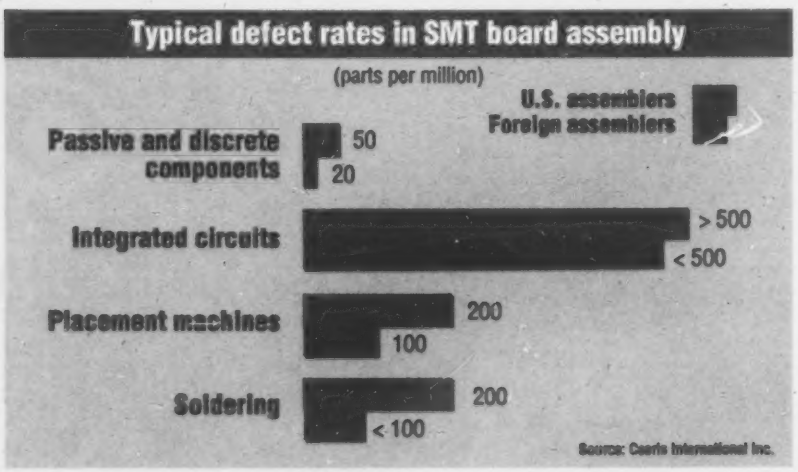
Unfortunately, manufacturing is still not the major concern for most high-level managers in the United States, thus the scarcity of statistics that managers can use to compare their own assembly operation with other operations. They regard it as a minor concern because manufacturing cost only amounts to a small percentage of a product's market price. This is shortsighted; if a new, reliable product is to be introduced rapidly, you must pay equal attention to design, marketing and manufacturing.

Our most successful foreign competitors are vertically integrated and consider manufacturing as important as design and marketing. Moreover, the role of manufacturing will become more important as digital products (cellular telephones, fax machines, laptop computers, etc.) become more consumer oriented and, therefore, more price-driven. Fortunately, with companies such as Digital Equipment Corp. and IBM now emphasizing design for production capabilities and in-house process development, good manufacturing practices are staging a comeback in the United States.

Hope ahead

Two out of every three operations in our study show ample room for improvement. Assembly subcontractors are the best performers. Captive operations, on the other hand, are lagging, primarily in just-in-time assembly, integrated assembly systems and standardization for manufacturability. Also, management performance is lowest where board mix is highest. When the types of different boards per year exceed 300, assembly becomes almost unmanageable. This is a big problem because, to be competitive, American electronics manufacturers must learn how to handle high-mix, small-lot manufacturing to maintain a competitive edge. High mix requires flexible assembly resources, which are both capital- and know-how intensive. Managing numerous small lots is also information- and quality-intensive.

But there is hope. Since Ceeris performed its first industry-wide analysis of electronics assembly in 1983, first-pass yields have increased by an average of 10%; leadtimes have been halved; and the overall level of automation has increased by almost 50%. This shows that U.S. electronics assembly is pointed in the right direction, but it has not yet reached the level we deem necessary for it to outperform its most successful foreign competitors. □



Oops! U.S. assemblers get the boo-boo prize

C Alterio

Little chip makers find novel ways to approach European markets

The smaller semiconductor houses aren't waiting to make it big in the States before tackling Europe's markets. Their secret: independent local operations

For most of the big broad-line U.S. semiconductor suppliers, and for many years, the U.S. market was big enough and exciting enough to absorb most of their attentions. Overseas opportunities did beckon, but generally they did not beckon brightly enough to merit major strategic change. And setting up facilities to serve them adequately was by no means cheap. So as a rule, the major merchant chip vendors rarely thought about overseas operations until they had become established successes at home.

But several of the semiconductor start-ups — companies like Sierra Semiconductor Corp., Xicor and Performance Semiconductor Corp.—are thinking differently, particularly with regard to Europe. Eager to tap into global opportunities with their narrower product offerings, they are setting up European facilities long before claiming fame and fortune in the United States.

These companies are drawn by a European semiconductor market that, according to the Semiconductor Industry Association, was worth $6.07 billion last year and will reach $6.3 billion this year. They are also particularly drawn by Europe's growing strength in custom chips, and believe in finding new ways to do business there —ways that should be instructive to many other small electronics firms as Europe gears up to become one homogenous trading market by 1992.

The younger chip vendors are thinking differently because business circumstances have changed considerably in recent years. The U.S. semiconductor market has been through its most severe slump ever and is more fragmented than before — factors that encourage vendors to look outward at markets, such as Europe, which may have been slow-growing but which have also been steady. Additionally, Europe has shown strong receptiveness to American semiconductor technology as its own edge has dulled, and it has proved able to come up with the funds that can help U.S. firms set up shop there.

Among the methods the small fry are using to gain a European foothold are: raising capital on local markets; finding European venture-capital partners; and buying local production facilities. For many, Europe is beginning to provide a generous slice of their sales, as well as adding new dimensions to their product and design-engineering expertise.

Probably the most successful company to have exploited this model was LSI Logic Corp., the Milpitas, California-based ASIC manufacturer. LSI expects to achieve more than $50 million in revenue from Europe this year; more than 30% of its total revenue in 1987 came from non-U.S. markets.

The company saw early in its genesis that peculiarities of the ASIC market dictated autonomous affiliates in Europe and Japan. "We recognized those markets [would] not be appropriately served without being close to the customer," says Robert Blair, LSI's vice president for sales and marketing.

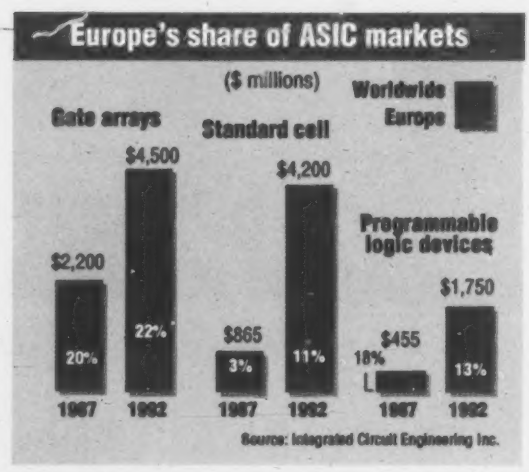
High-tech appetite

"There are really two parts to that mechanism," Blair explains. "First, we realized that equity to fund those affiliate companies could be raised in Europe and Japan. There was an appetite for high technology and a lot of money waiting for investment, but we had to offer stock priced in the local currency."

That realization was crucial. By using local currencies, LSI was able to avoid the damaging pitfalls of accounting for a fluctuating dollar exchange rate. This meant the affiliates' growth would not be an expensive burden upon the parent. "The companies had to be essentially self-financing; we didn't want to beg, borrow or steal from the parent for a market that was probably not fully understood," says Blair.

And second, was the willingness to relinquish total control over a subsidiary as the price for that flexibility. "Most companies struggle with that," Blair remarks.

LSI Logic currently has two



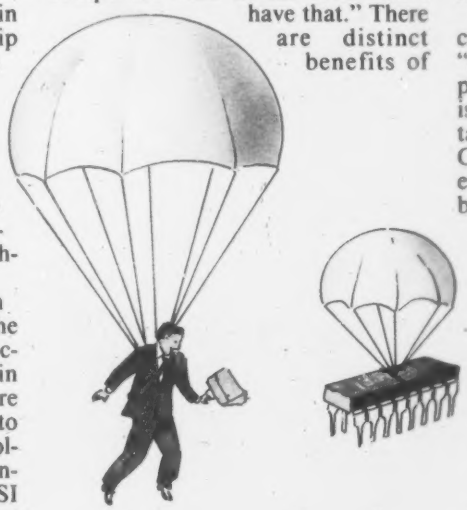
European lure: fast-growing ASIC sectors

semiconductor plants in Europe: one in West Germany, which is the firm's principal high pin-count plastic packaging plant, and an IC fab in England. Both factories have been partially funded by a local government grant and through finances which LSI Logic Europe raised in 1984.

In both cases the resident skills and resources exploit European strengths and are not duplicated elsewhere in LSI Logic's empire. Witness the chip plant in England. LSI Logic was quick to recognize the potential of a mixed analog/digital technology being developed by the British firm STC Plc. LSI Logic came to an arrangement with STC whereby it took over a new 6-inch wafer fab just completed by STC and obtained rights to the mixed-signal technology.

"We exploited specific European skills there," explains Blair. "At the time we wanted a mixed-signal process, there was no appetite for one in the U.S. But now there is a lot more talk about it so the U.S. is going to be a major customer of the technology." So Europe has become a "center of excellence" within the LSI Logic empire, exporting its particular technologies to the United States and Japan.

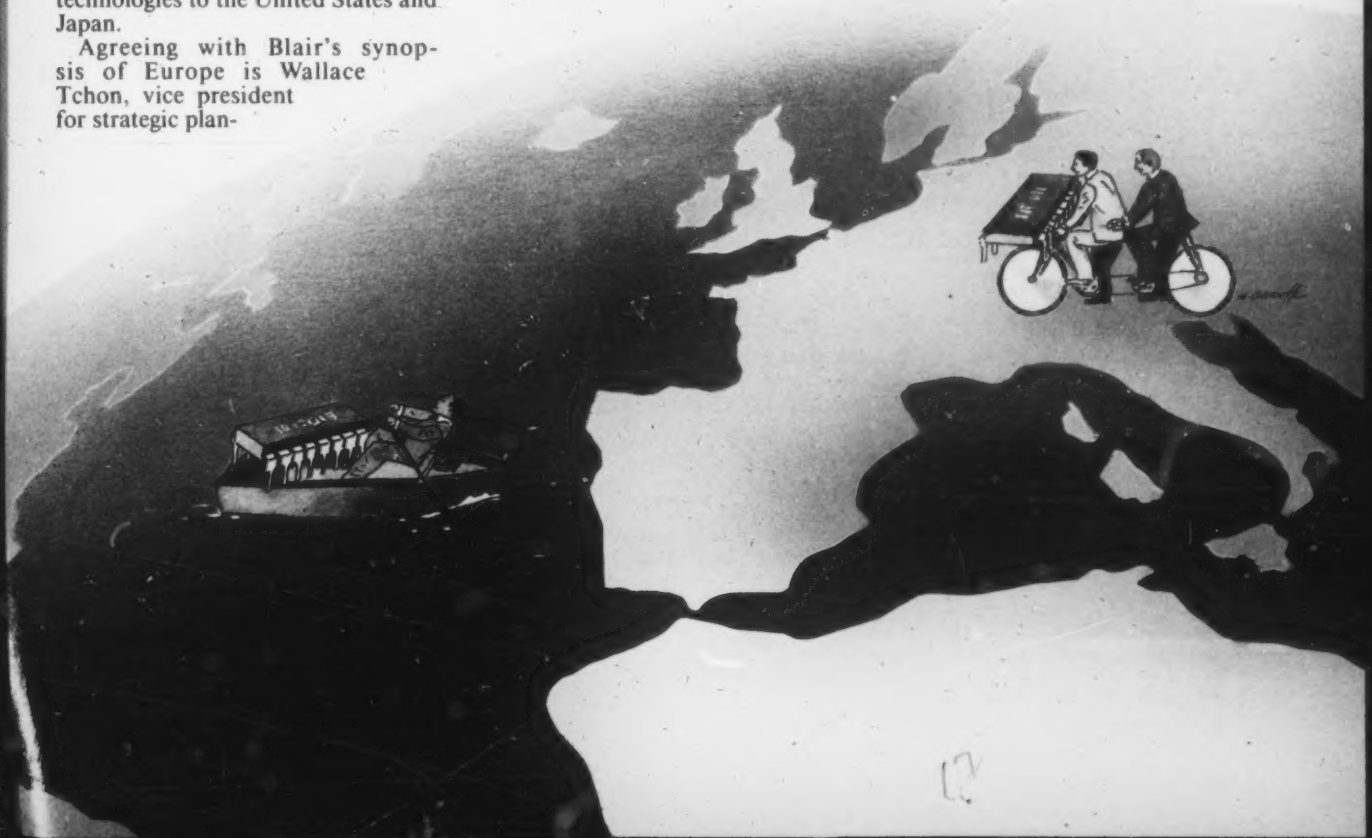
Agreeing with Blair's synopsis of Europe is Wallace Tchon, vice president for strategic planning at Xicor, a Milpitas-based manufacturer of EEPROMs. "It has always been an important part of our business; we also worked with the Europeans from early on in Xicor's life." About 20% of Xicor's revenue derives from Europe. Consequently, Tchon believes a strong European flavor pervades Xicor and a "lot of companies here in the U.S. don't have that." There are distinct benefits of such a relationship, he says.



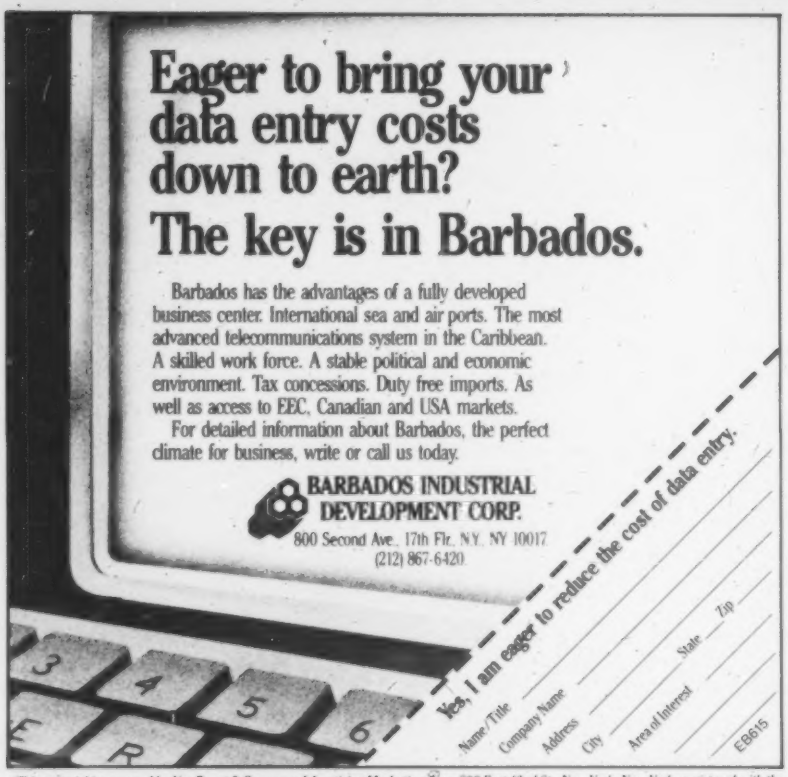
For instance, European customers display subtly different characteristics. "We tend to work with much longer relationships and deal with people that have longer horizons." Tchon says. That means Xicor gets a much better idea of each company's needs, which, in turn, can be translated into new products.

Xicor does not have a wafer fabrication plant in Europe, but it's a "matter we regularly look into," explains Tchon. The decision, he says, is a question of juggling fundamentals such as the European Economic Community's import taxes, the dollar exchange rate and the volume of business generated within Europe.

Four-year-old Sierra Semiconductor is also doing well with the Dutch operation it set up a year ago. With substantial equity funding from a Dutch venture-capital company — MIP Equity Fund — and with grants and loans from local government in Holland, the design and distribution center should return 15% of Sierra's sales this year, up from 5% of its $25 million revenue in 1987, accord-



Andrea Baruffi



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ing to president James Diller. He expects the operation to contribute up to 25% of the firm's total revenue in the next couple of years. "If you don't move offshore today, you've got offshore companies coming to you," adds Diller.

Do not dilute

Diller stresses that it is important to set up a facility that does not prove a dilution or diversion to the U.S. operations. Peter Hillen, director for strategic marketing at International Microelectronic Products, a San Jose-based custom MOS chip maker, adds that a European presence makes it much easier to win in local markets. "Everybody likes to do business with people who smoke the same brand of cigarettes they do. In European minds, there is a distinct difference between a division of an American company and a separate European company with ties to an American company."

Hillen, whose company owns 40% of the design and marketing facility it established last year in England, adds that Europe becomes increasingly important as U.S. systems houses with European facilities, like Apple Computer Inc., increasingly seek local semiconductor suppliers.

Joseph Rothstein, international sales and marketing manager for Performance Semiconductor, a Sunnyvale, California-based specialist in high-speed static RAMs and microprocessors, believes he is clear about European factory needs. He feels his company will need a wafer plant in Europe within the "next two to three years."

Performance has its own special requirements for an IC plant in Europe over and above merely producing chips there: it has a focus on military circuits such as the 1750A processor chip set which has become a U.S. military avionics standard. If that product takes off in Europe, performance would ultimately have to adopt all the local military standards prevalent throughout Europe. "That would be one good reason to build a plant," Rothstein says.

"We would need to serve the military markets as closely as we can and be physically close to our customers. And in our commercial products, I can see the trade running back across the Atlantic," he adds.

SIMON PARRY

Apollo's CEO has a simple message: Slow and steady wins the customers — and the profits. But can a workstation maker pass up pizzazz in times like these?

The Vanderslice vision: Less pizzazz, more profits

BY BETH KARLIN

Thomas A. Vanderslice has an image problem. Industry analysts, reporters and even some customers accuse the chairman and chief executive of Apollo Computer Inc. of being a bit, well, stodgy. In a market that has produced entrepreneurial megastars like Sun Microsystems Inc.'s CEO Scott McNealy, Vanderslice — with his pinstripes and low-key demeanor — sometimes seems to blend into the background.

"He could do with some pizzazz," says Laura Conigliaro, an industry analyst with Prudential-Bache Securities Inc. "Image can make a great deal of difference to investors and customers." Especially when you're competing with a master of promotion like McNealy. "Sun clearly has captured the emotional high ground," says Apollo's largest — and still loyal — customer, Gerard Langeler, president of Mentor Graphics Corp., Beaverton, Ore.

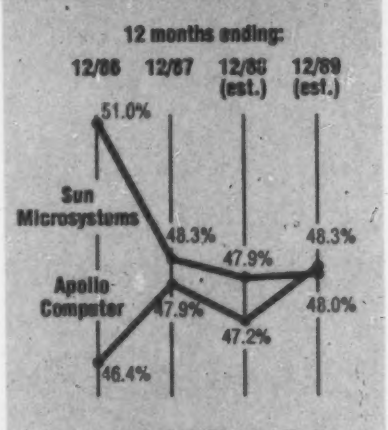
Through aggressive marketing, youthful exuberance and an emphasis on open systems, Sun last year edged out Apollo as the No. 1 supplier of technical workstations. "We're taking business away every month," claims Arun Taneja, acting director for workstation marketing at Sun, Mountain View, Calif. "And we intend to keep up the pressure." In the meantime, computer giants Digital Equipment Corp., Hewlett-Packard Co., IBM and even — recently — Apple Computer Inc., all have entered the fray.

Gerry Baskin

Apollo's Vanderslice: "We haven't been running around making rash promises"

In 1986, Apollo held the largest share of the workstation market: a 25% chunk. But in 1987, Sun took over: it shipped $645 million worth of workstations for a 26% share of the market; Apollo, with over $470 million, or 19%, came in ahead of both DEC, with $450 million; and HP, with $435 million; in workstation sales, according to Dataquest Inc. "We expect DEC to be our No. 1 competitor," says Vanderslice. Sun's Taneja agrees that Digital will be a front-line player: "We consider DEC more of a long-term threat than Apollo," he says. Digital executives were unavailable for comment.

Gross profit margins: Apollo versus Sun



Source: Prudential-Bache Securities Inc.

Even after its hefty round of price cuts on midlevel models, Apollo should top Sun in profitability by next year

For awhile it appeared that Apollo, which virtually created the workstation market in 1981, might get beaten at its own game. The company's sales continued to grow through the downturn of 1985, but its profitability did not, largely as a result of its defense of a proprietary operating-systems strategy. Sun redefined the competition when it embraced AT&T's Unix and preached the open systems philosophy.

But now the Chelmsford, Mass., firm is fighting back. While Vanderslice himself is content with a decidedly low profile, Apollo's image is looking a lot brighter these days. For the past two and a half years, Vanderslice has been quietly repositioning Apollo for growth. "We may appear conservative," concedes Vanderslice, who is growing weary of the constant comparisons with Sun. "We haven't been running around making rash promises and touting our stock. Outside we kept our heads down. But inside we've been working like mad."

Profits pay off

Lately, those efforts have been paying off. In its fiscal 1988 first quarter, ended April 2, Apollo reported record sales of $168.93 million, up 37% from the year-ago period. Earnings hit a new high as well, rising to $10.41 million, 62% above the same quarter last year. And the firm

shipped 7,400 workstations — more than any quarter in the company's seven-year history.

Coming on the heels of a strong 1987 fourth quarter, these results give analysts and company officials confidence that a turnaround is underway. "From a revenue and profitability standpoint, Apollo seems to be in a better position than Sun," says Vicki J. Brown, an analyst with International Data Corp. "Apollo is much more conservative and management has done everything to assure that it won't hit the wall again like it did in 1985. Sun hasn't stumbled yet; but it's growing so fast anything could happen."

However, Apollo recently slipped its conservative cover, borrowing a Sun tactic with price cuts of up to 35% on its Series 4000 Personal Super Workstation. Apollo is betting that the price reductions will generate a sales upturn that compensates for the lower returns.

Behind this bolder tactic lie more staid long-term strategies. While Sun's McNealy was getting much of the attention, Vanderslice was seeking a long-term remedy for what he hoped would be a short-term problem. After a devastating loss of $18.4 million in the third quarter of 1985 when computer demand dropped precipitously, Apollo derailed from its fast-growth track. The firm was committed to an expansion plan that would erode Apollo's profits until the company could rebuild its business. Vanderslice, president of GTE Corp. before he joined Apollo in 1984, moved on several fronts to guarantee that in the long term, Apollo would survive stiffening competition. Under his leadership, Apollo has:

- Diversified its customer base so that the three largest customers account for only about 15% of total business today, compared with 70% in 1985.
- Reduced geographic risk by expanding exports to more than 50% of annual sales, compared with less than 20% in 1984.
- Moved away from proprietary architecture and followed Sun's lead to open up the workplace and offer standarized products with Unix operating systems and Ethernet LANs.
- Now, Apollo has taken that strategy further by joining IBM and others to create an open software system.

Incensed that the Sun/AT&T alliance gave Sun first crack at designing products around Unix, Vanderslice led a revolt of workstation makers. "It was stupid of AT&T to take Unix proprietary," says Vanderslice with uncharacteristic venom. "I was incredulous."

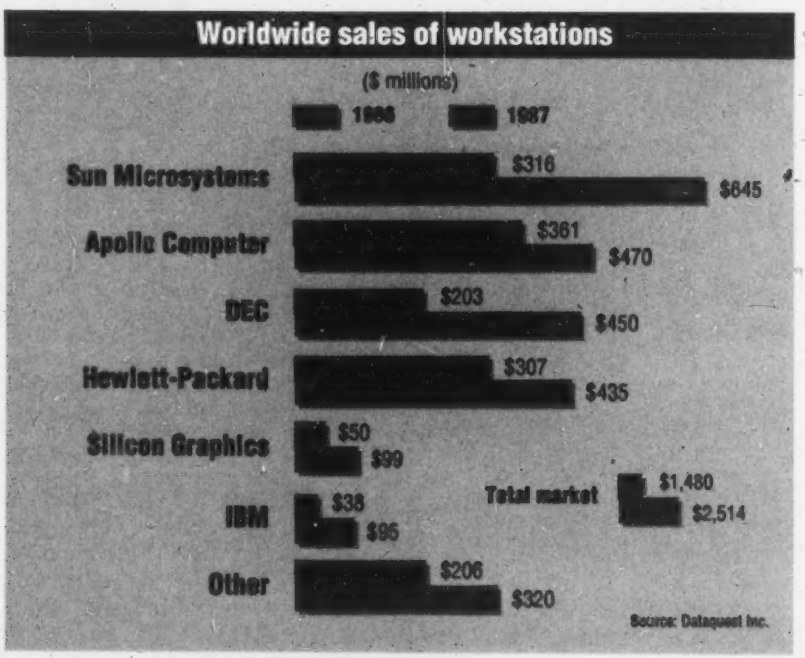
Apollo counterattacked by signing up IBM, Digital, France's Bull and Germany's Siemens and Nixdorf as charter members of the Open Software Foundation. The group will initially spend more than $90 million to develop a version of Unix that will allow all members' hardware to operate with the same software. "We are committed to open systems and this is our game plan for getting there," says Vanderslice.

This approach is far removed from Apollo's previous proprietary strategy. "Our mistake was not giving users a choice," admits J. Michael Greata, Apollo vice president for research and development and one of the firm's founders. "We should have offered both flavors [Apollo's proprietary Aegis and Unix]. We could have gone out of business if we kept trying to convince customers that one flavor was better than the other."

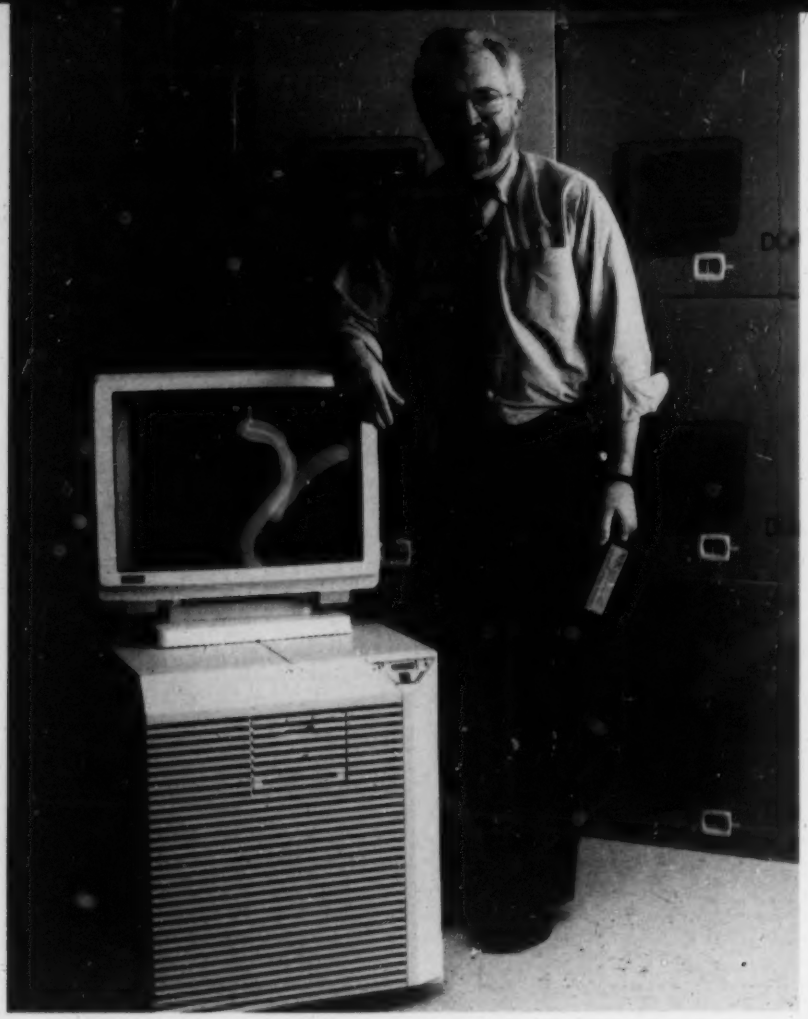
In February, Apollo introduced its Domain/OS operating system, a purer model of Unix than before. And in March, it introduced its high-end Series 10000 supercomputer, based on Apollo's own PRISM (parallel reduced instruction set multiprocessing) architecture and which boasts supercomputer-like processing speeds. "Only now is Apollo's old image beginning to give way," says Prudential-Bache's Conigliaro.

Domain/OS incorporates networking computer features into the operating system and makes it easier for third-party software developers to port applications. Scheduled for shipment in June, the new operating system offers three environments: Berkeley 4.3 Unix, AT&T's Unix System V Release 3 and Apollo's Aegis operating environment. "The world is moving to a distributed environment," says Conigliaro. "And Apollo is as much a part of this as Sun."

The Series 10000 reflects Apollo's decision to try to dominate the high-end of the workstation market and let others battle it out for the extreme low end. The line between high-end personal computers and low-end workstations is fading. "Selling boxes is not always the same as selling workstations," insists Vanderslice. "We concentrate on workstations and workgroups."



Last year, Apollo was eclipsed by Sun in sales volume



"Our mistake was not giving users a choice of operating systems," says Apollo R&D vice president J. Michael Greata. That's a mistake Apollo is fixing with Domain/OS

Gerry Baskin

It's too early to tell if Apollo will ever regain its premier position. But even if it doesn't, Vanderslice is convinced that there will be enough business for all of the leading players, although some of the less successful ventures may fall by the wayside. Industry sales increased about 150% last year alone, to $2.8 billion from $1.1 billion, according to IDC of Framingham, Mass. And sales are projected to grow at around 30% annually for the next several years, a growth rate that Vanderslice says Apollo can keep up with.

History is on his side. According to Prudential-Bache, Apollo's revenue growth has never fallen below 30% a year. That gives the investment brokerage confidence in predicting that Apollo will clear 1988 revenue of $720 million, with over $860 million for 1989.

Sistine chapel

Workstations, sophisticated desktop computers linked together in powerful networks, originally were developed for engineering applications such as circuit design and chip layout. But now, with their remarkable graphics, they are finding their way into software development, watch design, animation, financial trading, air traffic control, space station design and even preservation efforts. In Rome, for example, Apollo computers are helping painters determine the original color of Michelangelo's work on the ceiling of the Sistine chapel.

The distributed-processing concept of workstation networks is consistently winning converts away from the shared-logic approach with minicomputers or mainframes performing the tasks. Popularity of desktop workstations continues to grow as unit costs decline and computing power increases. Workstations range in price from just under $4,000 — Apollo's low-end Series 3000 Personal Workstation begins at under $5,000 — to more than $120,000.

Newcomers such as Ardent Computer Corp., Sunnyvale, Calif., and Stellar Computer Inc., Newton, Mass., are challenging Apollo at the high end, attempting to bridge the gap between high-end workstations and supercomputers. And at the low end, there's even more competition, with powerful personal computers, many with Intel Corp.'s 80386 microprocessor on board, competing with workstations. Japanese PC makers are also coming in at the low end, though it's unclear how well they will fare in the crowded field.

Sun and Apollo are meeting each other across the spectrum. "They moved up from the low end and we moved down from the high end," says Cheryl Vedoe, Apollo director for workstations, graphics and service. "At the high end, we'll continue building our 10000 well into the 1990s." Combining PRISM architecture with supercomputer technology, the Series 10000 features multiprocessors and 64-bit data paths based on supercomputer designs. Its central processing units feature high-speed integer processors and independent coequal floating point processors providing parallel instruction execution. In its single-processor version, Apollo claims it will offer from 15-to 30-MIPS processing speed for under $70,000, and up to 100 MIPS with four processors for about twice that.

Uncharacteristically, Apollo announced the Series 10000 on March 1, well before it was ready to ship in the third quarter of this year. Sun, for one, isn't convinced that the system will be delivered anytime soon. "It might as well be infinity as far as customers are concerned," snipes Sun's Taneja.

Sun is cocky. And for good reasons. "Sun is the best high-technology marketing company in the world," says Mentor's Langeler. But being the best marketing company doesn't necessarily guarantee success. "The hottest platform of the year doesn't always serve the shareholders and customers in the best way," according to Langeler who, while considering adding a second supplier, does not intend to abandon Apollo. "We would never leave Apollo," he says. "We have too many happy customers."

The conservative, controlled-growth approach could win in the end. And that's what Apollo — and Vanderslice — are betting on. "People love entrepreneurs and are deeply suspicious of professional business-

Cheryl Vedoe, Apollo's director of workstations: "Sun moved up from the low end and we moved down from the high end"

Gerry Baskin

men," says Vanderslice. "But often the professional businessmen remain long after the flashy entrepreneurs burn themselves out. Long-term success takes much longer to seed." If Vanderslice seems rankled by the disparate images of the entrepreneur and the seasoned businessman, it's because he falls into the latter, less glitzy, category. He has been a professional businessman for over 30 years: before his tenure at GTE, he spent 23 years at General Electric Co.

Ferrari Testarossa

One reporter for a major daily business newspaper believed that Vanderslice's low profile gave him the perfect story on East Coast-West Coast culture clash: seeing California-based Sun executives in their sporty import autos, he reasoned that the staid New Englanders at Apollo would drive nothing more exotic than Lincolns. He was wrong. Vanderslice drives a Jeep, while his chief technical officer, David L. Nelson, pilots a Ferrari Testarossa.

Shortly after he took over at Apollo, Vanderslice began cautioning the financial community not to expect spectacular — or even very good — earnings for the near term. "We will not deliver great profits until we grow to $150 million or $160 million a quarter," he told Wall Street. Apollo had a plant designed to produce that much product and Vanderslice realized that the company's earnings would grow only marginally until that magic figure was reached. No further expansion is needed for several years, he says, because Apollo's manufacturing facilities have a capacity of $1.2 billion worth of sales running at full capacity.

Had Apollo not implemented the hefty price cuts on its Series 4000 models, Vanderslice's plans might have given the company an edge in profitability this year, according to Wall Street observers. Prudential-Bache was predicting that Apollo's gross margins would have reached 48.9% for the year ending December 1988, leading Sun's by one percentage point. But even with the price cuts, the investment brokerage now forecasts that the gross-margins prize will be Apollo's next year: 48.3% for the year ending December 1989, against 48.0% for Sun.

But Vanderslice does not make hay with predictions. While competitors are boasting about anticipated increases in earnings and revenue, Apollo has played it close to the vest; maybe a little too close to the vest, according to some. Even Vanderslice admits he he may not be enough of a cheerleader to encourage investors. "There must be something wrong with my approach," he says, contrasting Apollo's stock price in 1982 with its lower figure today.

Upon arriving at Apollo in 1984, one of Vanderslice's first — and most critical — decisions was to determine whether or not Apollo should follow Sun's lead and develop standardized workstations for a multivendor environment. "It was difficult," recalls Vanderslice. "Some of our people had developed what they considered a much better system."

Many customers agree. "It's outstanding," says Dennis Gaugham, manager for development and engineering with the Software Productivity Consortium (SPC), a group of 14 aerospace and electronics companies that have teamed up to develop advanced software tools and techniques. "We wanted to make sure that we had that kind of sophistication," says Gaugham. The consortium also wanted to be certain that Apollo's products could be integrated in a multivendor workplace. And, says Gaugham, who professes a dispassionate and objective approach to computer purchases: "Apollo has done a great job of opening up."

SPC, which has installed 157 Apollos to date, is considered by workstation manufacturers to be one of the pioneer test sites for a multivendor approach. SPC has three Sun workstations, a Digital Equipment minicomputer and about a dozen Digital workstations, with plans to acquire more products from all the companies. "Our major customers all have one of everything," says Gaugham. Crucial to SPC's mission, then, is to develop a powerful network of workstations from different vendors.

Apollo still hasn't decided how much of its proprietary technology it will make available to customers and

competitors. While Sun is virtually inviting other manufacturers to copy its products and build clones, Apollo isn't sure that's the best way to go. "It's a mixed blessing," says Vanderslice. "In some ways you get more people to use that technology. On the other hand, if you license your technology it makes it easier for people to copy your equipment."

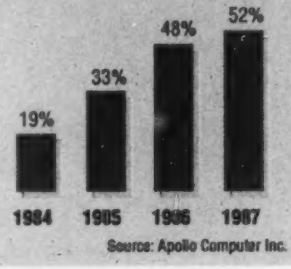
When Vanderslice came to Apollo, the company had only three customers — Mentor Graphics, Calma and Auto-trol Technology Corp. These days, Mentor accounts for only 10% of Apollo's business, compared with 25% before diversification efforts. "Our relationship has actually improved since we became less important to them," says Langeler. "They have become a much better listener and we have become more a good friend and consultant" than a complete driver of future technology.

Crippling loss

Analysts worry, however, that even at 10%, the loss of Mentor could cripple Apollo. While Langeler notes that Mentor is actively evaluating Sun and DEC products, he insists that his firm would never completely abandon Apollo. Last year, Mentor and West Germany's Siemens AG both signed $100 million contracts with Apollo. At press time, Mentor and Apollo expected to soon successfully conclude negotiations for another 12- to 18-month contract. Other customers include: Chicago Research and Trading Group Ltd., an options trading firm; Lockheed Corp. (also a big Sun customer); Seiko Watch; Waseda University, Tokyo; and Malaysia's public works department.

Overseas sales

Apollo's growing overseas sales (percentage of total sales)



Source: Apollo Computer Inc.

Strategy, Vanderslice-style: boost those overseas sales

Vanderslice points to the rapid expansion overseas, which now accounts for half of the company's total revenue. "We've probably grown a worldwide infrastructure faster than any other company in this business," boasts the usually modest Vanderslice. Selling directly into 20 countries, Apollo has operations in India, Scotland and now in China.

In Chelmsford, Apollo continues to develop future products. Some analysts expect Apollo to stress more sophisticated workstations and leave Sun and others to battle it out at the low end. But Apollo executives hint that the firm will introduce some low-end products soon. Industry watchers are betting on machines based on Motorola Inc.'s 68030 microprocessor. Meanwhile, Apollo is excited about its latest entries. "This is nothing less than a new era for computing," says Greata. "There's a visceral excitement about being at the leading edge."

How leading that edge is remains to be seen. Industry observers still maintain that if Sun's bold growth pattern continues, its revenue will be nearly twice that of Apollo's exiting 1989, as will its R&D spending. But this doesn't stop Vanderslice from waxing enthusiastically about Apollo's future. "We're getting close to a couple of hundred new customers every quarter," he says. "We're going to experience some great growth over the next three or four years." □

Apollo's foreign forays

Since Thomas A. Vanderslice took over at Apollo Computer Inc., the Chelmsford, Mass., firm has greatly increased foreign sales — from 18% of total sales in 1984 to more than 50% today. This expansion of overseas business has, in turn, led to an expansion of overseas manufacturing and service facilities. Worldwide, Apollo has 76 sales and service facilities in more than 25 countries. It is expanding its European repair and manufacturing center in Livingston, Scotland, which serves as the final assembly and test location for most of Apollo's international sales. "Ahead of Sun, Apollo put more of its resources into building up its international base," says Laura Conigliaro, an analyst with Prudential-Bache Securities. U.S. manufacturing facilities are in southeastern New Hampshire.

Since November, Apollo has announced plans for workstation assembly operations in India and a service center in China. The new Instrimpex-Apollo Computer Service Center and bonded warehouse at Qing Hua University in Beijing is the first workstation service center in China.

Last year, Apollo sold 600 workstations in China; 40% of those in Beijing. With the rapid growth of Apollo's customer base, company officials noted, Apollo has signed a contract with Instrimpex to establish a second service center and bonded warehouse in Shanghai. "We firmly believe that after-sales maintenance is a key factor to success, and this new service center will provide the best possible service to our customers in China," says Ed Goldman, Apollo's Asia-Pacific regional manager. The facility will be staffed by a team of local engineers from the Department of Computer Science at Qing Hua.

In India, meanwhile, Apollo has joined forces with HCL Ltd., India's largest computer manufacturer, to build workstations at a new facility outside New Delhi — the first of its kind in India. Officials of both firms said the HCL-Apollo manufacturing operation is an outgrowth of increased demand for Apollo workstations by engineers, engineering students and technical and business professionals in India. "Apollo will use 1988 to build upon its support infrastructure," says Conigliaro, "providing customers with full technical, marketing and support capabilities." □

How Micron is marching through the DRAM minefield

Customers are clamoring for Micron's chips as prices and profits soar. But CEO Parkinson still needs that hard hat

BY ALDEN M. HAYASHI

When Micron Technology Inc. entered the semiconductor business in 1978, people snickered. Micron's only product was DRAMs, commodity memory chips that the Japanese were already churning out by the millions. In addition, the company was not headquartered in Silicon Valley but, of all places, in Boise, Idaho. "We weren't taken seriously at first. They called us potato heads," remembers Juan Benitez, Micron president.

People are not snickering anymore. Due to the current worldwide shortage of DRAMs, customers who once snubbed Micron are now begging the company for chips. Indeed, Micron's sales should grow nearly 200%, from $91 million in fiscal 1987 (ended last September) to $267 million this year, according to a forecast by Prudential-Bache Securities Inc. Estimates from Integrated Circuit Engineering Corp. (ICE) of Scottsdale, Ariz., place the worldwide DRAM market at around $2.8 billion this year.

Although Micron is currently in the proverbial catbird seat, its position there is anything but secure. Several factors could unbalance the company:

- Intensifying competition in the DRAM market as semiconductor companies consider entering, or reentering, the marketplace.
- The next — and some say imminent — market downturn. The last downturn left Micron submerged, from March 1985 to May 1987, in a $71 million pool of red ink. At the time, some industry analysts doubted whether the company would survive.
- Less-than-harmonious relations with some key customers. Tensions are running high during these times of severe memory chip shortages. Already one customer is suing Micron for allegedly reneging on a contract.

The acute DRAM shortage and Micron's subsequent success have not gone by unnoticed by many of the major U.S. semiconductor companies, some of which retreated from the market several years ago. National Semiconductor Corp., among others, is reportedly weighing the pros and cons of reentering the marketplace, possibly by doing foundry work.

And foreign chip companies are also itching for a piece of the U.S. market, which topped $860 million last year. Europe's SGS Thomson Microelectronics Inc. is currently evaluating a plan to begin building DRAMs in its empty Phoenix, Ariz., facility. South Korea's Goldstar Technology Inc. is gearing up for a DRAM product launch in the United States later this year.

Steve Welsh

Micron is building a new fab to support the burgeoning DRAM market. Says chairman Joe Parkinson: "The momentum is very much in our favor and we expect that to continue for some time"

A fast-moving train

Nonetheless, Joseph L. Parkinson, Micron chairman and CEO, remains

undaunted. "Some people say the DRAM business is like a fast-moving train," he says. "If you get off the train, it's very tough to get back on because you've got to make up for a lot of lost ground."

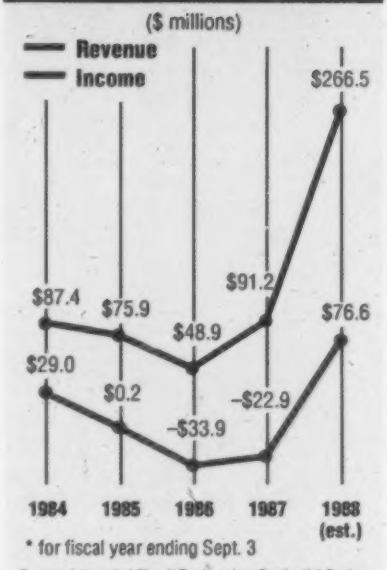
Staying abreast of the competition will not be easy for Micron. The company has to bring up a new wafer fab this year; continue lowering manufacturing costs; and make the technological transition to 1-megabit DRAM chips, capable of storing four times as much memory as 256-kilobit DRAMs.

Three months ago, Micron broke ground on a 100,000 square foot facility which will employ 1,000 new workers and double the company's manufacturing capacity, according to Parkinson. Dataquest Inc. of San Jose estimates Micron's investment at $150 million. If there are no production snags, Micron could be making chips there as early as April of next year, according to Parkinson. He is counting on the new fab, Micron's third, to help the company capitalize on the current shortage in the marketplace. "Right now, production is our limiting factor," he says. Indeed, new customers must wait months for Micron's DRAMs.

However, as other chip companies begin entering or reentering the market, and as the established DRAM vendors also begin to step up their production, supply will quickly close in on demand, threatening Micron's current status as the U.S. vendor of the hour. DRAMs, after all, are commodity chips and Japanese rivals, with proven manufacturing efficiency, could once again wreak havoc in the marketplace.

As the DRAM market recovers . . .

. . . so do Micron's finances*



* for fiscal year ending Sept. 3

Source: Integrated Circuit Engineering, Prudential-Bache Securities and company reports

An idiotic concept

Such pessimism infuriates Parkinson. "Just because it's a manufacturing game, does that mean that the United States is not going to be in it? We don't feel that just because the Japanese are in a market . . . that that's any reason to get out of it. . . . That strikes me as an absolutely idiotic, foreign, alien concept. Where I grew up, you don't concede that someone else can outwork you, outmanufacture you, or outthink you," lectures Parkinson, a workaholic product of rural Idaho.

Indeed, Parkinson asserts that Micron has made great strides in improving its manufacturing efficiency. According to Randal W. Chance, executive vice president in charge of manufacturing, production costs have decreased by more than 50% over the past year. Such impressive cost cutting allows Parkinson to brag, "We can compete against the Japanese head to head, toe to toe."

But there are indications that Micron may have to sharpen up its quality control. Two and a half years ago, Sun Microsystems Inc. filed a $6 million lawsuit against Micron alleging that the company knowingly shipped poor quality chips that caused a two-month shutdown of Sun's plant. The lawsuit is pending. "Micron's chips are still not of the greatest quality," adds a source from an independent testing laboratory.

Parkinson denies rumors that Micron is having quality problems in manufacturing 1-megabit DRAMs. He asserts that his company is already producing those chips in substantial quantities. In fact, 1Mb DRAMs presently account for more than 10% of Micron's total sales, says Parkinson. "Our production of 1Mb DRAMs is a *marketing* driven issue, not a technical one," insists manufacturing vice president Chance, in a subtle gibe at the several Japanese manufacturers that have reported difficulties in handling the transition to making 1Mb DRAMs.

No God-given right

The DRAM chip shortage has caused great tension in the marketplace. Last March, Atari Corp., a longtime Micron customer, filed a lawsuit against the company alleging that it had reneged on a contract to sell DRAMs at a specified price. According to court documents, Micron failed to ship the DRAMs at $3.75 apiece even though the company's cost of manufacture was only about $1.35. In its response, Micron denied that any such legitimate contract existed.

Although Parkinson will not comment on the litigation, he does express extreme resentment at being forced, during the last recession, to sell chips at bargain basement prices. "Customers now think that they have the God-given right to buy DRAMs for below cost," he huffs.

Even in these times of severe market shortages, Parkinson asserts that some customers have not yet adjusted to the new reality. "There's this tremendous attraction — it's almost like having sex — to the notion of being able to buy DRAMs at below marginal costs," he says.

Consequently, Parkinson questions whether Micron will be able to enter into any long-term alliances with its OEM customers. The company did, however, strike up a major deal last March with semiconductor manufacturer Intel Corp., through which Intel will resell Micron's memory chips. (Intel — like Advanced Micro Devices Inc., Motorola Inc. and National Semiconductor — stopped making DRAMs several years ago.)

Perhaps the greatest benefit of the current market shortage is that Mi-

cron has now been able to sell DRAMs to major customers that, until recently, had snubbed the company. "In the past, customers viewed Micron as a supplier of last resort," says Christopher D. Kirby, semiconductor analyst for Rothschild Inc. of New York City.

Even Parkinson admits as much. "One customer told us: 'If you're here five years from now, then come and talk to us,' " he remembers. "Just two or three years ago," he adds, "substantially all of our products were shipped to Atari, Commodore and Apple.... Today, we sell to almost everyone.... We have total coverage of the worldwide computer business." In fact, Micron now boasts over 1000 customers, says Parkinson.

Not playing fairly

How Micron is faring with its expanded customer base is unknown. In a subsequent court filing, Atari alleged that Micron reneged on its contracts with other companies as well. "Micron is not playing fairly with prices," grumbles the president of a major personal computer manufacturer in the U.S.

Other customers, however, have a different story to tell. "There are some people out there taking advantage of the marketplace but Micron has been fair," says William Calhoun, director of corporate procurement for Prime Computer Inc. of Natick, Mass. Adds Charles Smith, a senior vice president for industrial distributor Hall-Mark Electronics Corp. of Dallas, "Micron has been a very good supplier of ours."

Maintaining happy customers will be crucial for Micron, particularly given the cyclical nature of the semiconductor market. Parkinson admits that one reason Micron was badly hurt during the last recession was because the company's customer base was limited. "We're not as vulnerable anymore," he asserts. Rothschild's Kirby agrees: "Micron has been building quality customer relationships that will help carry them through the next downturn."

To help weather the next recession — which some Cassandras are predicting for 1989 — Micron has also been busy diversifying its product line. "If you've got a few other products, you've got a better chance at keeping the ovens burning," says Parkinson.

Micron recently introduced SRAM and video RAM chips and now sells memory board products as well. Critics, however, doubt whether the company will be able to diversify quickly enough before the next downturn occurs. Sales of 256K DRAMs still account for more than 80% of Micron's total sales, according to Prudential-Bache. "They're still basically a one-product company," says William J. McClean, ICE analyst.

Before the next recession arrives, Micron must be careful in managing its explosive growth. So far, the company has received rave reviews from the investment community. "Their management team has done an admirable job to date. They've shown that they're survivors," says E. Lawrence Hickey, investment analyst for First Analysis Corp. of Chicago.

Micron has been busy...

1. Expanding its facilities. To alleviate the current DRAM shortage, Micron commenced the construction of a new fab last March which should double the company's manufacturing capacity. Production could commence as early as April of next year.

2. Driving down costs. During the past year, Micron managed a greater than 50% reduction in manufacturing costs due, to a large extent, to the shrinking of chip die sizes. With the smaller dies, the company is now able to reap more chips per the same size silicon wafer.

3. Making the transition to 1-megabit DRAMs. While several Japanese competitors have had trouble hurdling the technological obstacles, Micron claims that 1Mb DRAMs already account for more than 10% of total sales.

4. Signing up new customers. A few years ago, most of Micron's products were shipped to Apple, Atari and Commodore. Today, the company boasts over 1000 customers, not one of which accounts for more than 5% of monthly shipments.

5. Diversifying away from DRAMs. Micron now offers a product line of SRAMs, video RAMs and memory board products. The company's long-term goal is to have a 50-50 split between sales of chips and those of board products. □

Little Bighorn revisited

Micron's management has not always been so sage. In a maneuver reminiscent of General Custer at Little Bighorn, the company ambushed the DRAM market four years ago by slashing prices almost in half, even though demand was still in excess of supply. The maneuver startled the Japanese and prompted them to retaliate, causing prices to begin a downward spiral that many industry gurus contend led to the market's eventual collapse. The U.S. government, goaded by Micron, finally intervened and found the Japanese guilty of dumping, or selling at prices below cost.

The resulting U.S.-Japan semiconductor trade pact, which set price floors on certain chips imported by the Japanese, allowed Micron to survive, asserts Sheridan Tatsuno, Dataquest analyst. Not true, says Parkinson, who insists that the situation, even at its worst, was never bleak. Parkinson credits Micron's survival to the unwavering loyalty of the company's board of directors, comprised of Idaho businessmen who were Micron's original investors. If the board had instead been controlled by typical venture capitalists, says president Benitez, "We would have been shut down by now."

The next time the market sours, it will be the Japanese who will suffer most, contends Parkinson. "I think the upcoming shakeout will be on the other side of the ocean because they now have a lot of disadvantages that we once had: a strong currency, high wage rates, astronomical land costs and construction costs that are out of sight."

Parkinson's assessment may be accurate but whether his company can endure the next recession is uncertain. Still, Micron has managed to survive thus far in a marketplace where many larger, more experienced U.S. companies have failed. For this feat alone, tenacious Micron has silenced its critics' snickers. "I don't think they're calling us potato heads anymore," says Benitez. □

Boeing's AWACS deal runs into trans-Atlantic flak

The Brits claim Boeing is giving their subcontractors too little too slowly. U.S. critics fear such offset defense deals help foreigners too much

A year and a half after the British government awarded a controversial $1.2 billion contract to The Boeing Co. for E-3 Airborne Warning and Control System (AWACS) planes, a debate over the efficacy of the deal has re-emerged. British critics are accusing Boeing of being lax in its commitment to share the contract with British firms, claiming that it has reneged on its "offset" agreement. The situation is particularly sensitive because the British canceled their own billion-dollar airborne early warning program in favor of Boeing.

On this side of the Atlantic, a similar — if somewhat less vicious — debate is underway concerning the offset issue in general. In both the halls of Congress and in offices of defense contractors, the discussion centers around the pros and cons of offsets as they affect the U.S. economy and the country's defense. Some critics contend offsets contribute to loss of American jobs and business, while others argue the opposite.

The issue of offsets — whereby a nation buying a defense system does so only in return for participation in production of the defense system or through other trade reciprocity — is of considerable concern not only to prime contractors in America's defense-electronics industry, but to subcontractors as well. Subcontractors are finding that they have critical roles to play in major deals such as Boeing's AWACS agreement.

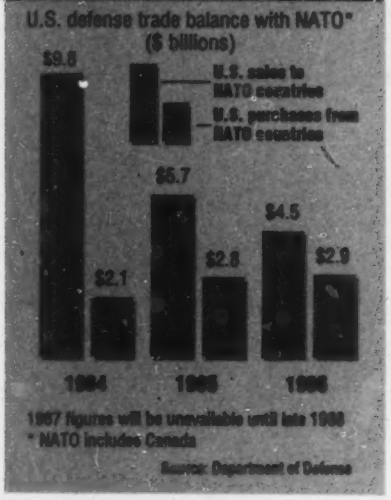
The issue is worrisome not only because the defense-electronics business is losing momentum — total procurement and RDT&E spending of $45.5 billion this year will dip to $44.5 billion in 1990, according to the Electronic Industries Association — but because imports of defense gear are growing. Studies by the Commerce Department show that the ratio of U.S. exports to imports of military merchandise fell from over 17 to 1 in 1982 to 3.5 to 1 in 1986, much of this attributable to a tripling of imports in that time.

Basically, an offset agreement allows a country buying a defense system to ensure that its own industry will benefit from the purchase either by building the system itself or by some form of indirect reciprocal trade. Offsets can involve technology transfer, coproduction or licensing agreements. Most of the countries that U.S. defense contractors deal with insist on offsets — Saudi Arabia, NATO countries, South Korea, Pakistan and Australia, to name just a few. The U.S. government, however, does not normally enter directly into offset agreements for its own foreign procurements.

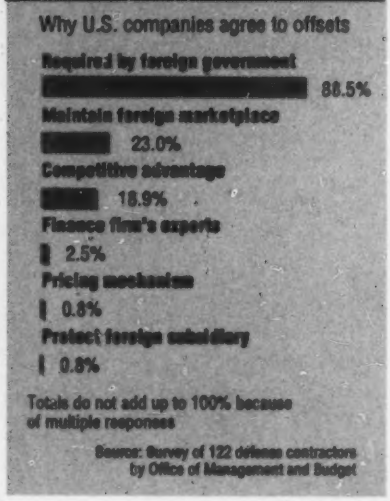
A study conducted by the Office of Management and Budget concludes that, in the past, offsets have had either no effect or a marginally positive effect on U.S. industry. The OMB estimates that between 1980 and 1984, U.S. defense-related offsets amounted to $2.4 billion, or 19.4% of the $12.4 billion in defense exports during those five years. The report says that while inefficiencies often increase as a result of offsets, revenue, profits and costs of the U.S. defense industry were not negatively affected.

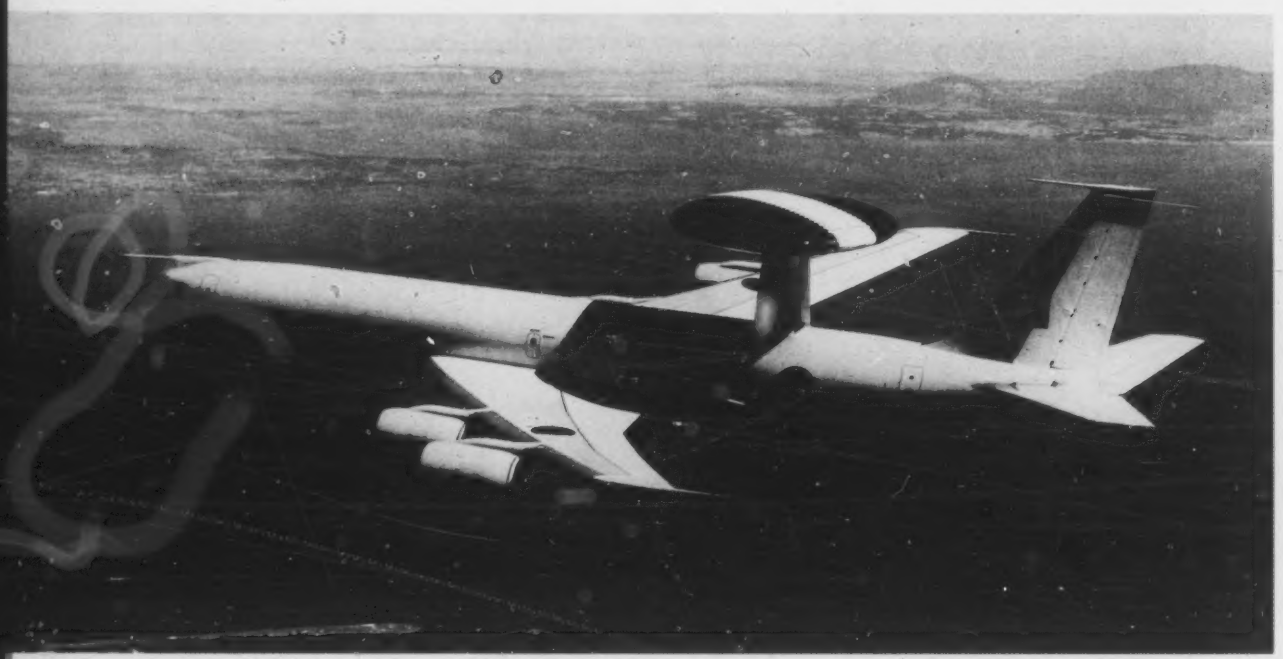
While most offsets in the past have involved modest amounts, Boeing's sale of seven E-3 AWACS planes to Britain is an exception. In its enthusiasm to win the contract, Boeing set a company precedent and raised some eyebrows in the defense industry by agreeing to a 130% offset. In other words, Boeing agreed to accept 30% more in European trade than it

America's dominance in military equipment is eroding...



...partly because U.S. companies agree to offset deals





Boeing's E-3 AWACS aircraft — early warning for AWACS operators but none for U.S. defense electronics subcontractors

would get for the AWACs it sold. Shortly after the deal was signed the French ordered four of their own AWACS from Boeing under more or less the same conditions. Concerning the British sale, a source within the British Ministry of Defence (MOD) says that some of Boeing's competition were willing to go even higher than 130%.

Shocked subcontractors

The deal shocked Boeing's U.S. subcontractors, who were not privy to the negotiations. Says one subcontractor: "Boeing's management moved quickly and decisively; [the deal] was not based on any kind of agreement with any of Boeing's subcontractors." It has also caused some concern within the Department of Defense because the agreement did not involve the U.S. government as the broker in a formal foreign military sale (FMS). Even though the top echelons of the U.S. government were backing the deal, DOD bureaucrats felt they had been left out of the action, sources say.

One of Boeing's subcontractors that lost business as a result of the offset deal was Hazeltine Corp. Siemens AG, the German electronics company, beat out Hazeltine for the data display contract, probably because of its proximity to the British and French markets. Hazeltine has had a long-standing technology-transfer relationship with Siemens in many areas including data displays, says John Colombo, director for offsets at Hazeltine. According to a Boeing spokesperson, Siemens has a "healthy load" of the offset commitment.

Boeing has been given eight years to satisfy its offset commitment and it claims it will have no trouble in doing so. The company expects about 10% will be applied directly to AWACS subcontracting to British companies, while the remaining 120% will involve indirect reciprocal purchases from Britain, mainly in high-technology products. Boeing made its first formal semiannual report to the British Ministry of Defence last October, outlining its progress in satisfying the offset requirements. A second report was sent to the MOD in April.

The first report included $141 million, of which Boeing and its subcontractor Westinghouse Electric Corp., maker of the main AN/APY-2 radar system for the AWACS, expect to get about $110 million approved. The British critics' hue and cry comes at a time when the MOD is making its judgment on that request, so it could affect whether that $110 million actually is granted.

Both sides in the deal were initially satisfied with the 130% offset. The British insisted that 130% was more than enough to create new jobs and opportunities despite the cancellation of the $1.4 billion Nimrod project, developed by General Electric Co. (Britain's GEC, no relation to the U.S. GE). Boeing was pleased with the contract because it meant that the AWACS was the dominant system in the airborne early warning market worldwide. It also means that production of AWACS in Seattle will continue, thus saving millions of dollars in shutdown and start-up costs while preserving an estimated 2,000 U.S. jobs. Nonetheless, British sources claim an estimated 2,000 jobs were lost as a result of Nimrod being canceled.

A year and a half after the signing, the Boeing-MOD honeymoon is truly over. The British press claims new business has been slow to materialize and no new jobs have been created as a result of the AWACS purchase. Although Boeing and its subcontractors agree that progress has been slow, they insist there is no intention to try to back out of the agreement.

On the contrary, Boeing takes its offset commitment very seriously, in-

sists Ralph Backes, offset and countertrade manager at the Information Systems Division at Boeing Aerospace. Along with some of its subcontractors, including IBM and Westinghouse, Boeing conducted a symposium in Britain in February 1987, with over 200 qualified defense companies, and it is evaluating projects now. Most of the 11 main U.S. subcontractors have signed "best effort" agreements with Boeing that say they will attempt to satisfy their proportion of the 130% offset.

An IBM spokesperson says Big Blue has yet to sign any contracts with British companies but it is currently involved in negotiations. IBM's Federal Systems Division is responsible for the computer, the memory drums and the operator computer control aboard the AWACS. Similarly, Eaton Corp., maker of the AWACS identify friend or foe (IFF) system, is following up with British companies for multilayer printed circuit boards and power supplies, says William Fleig, director of Identification Systems at Eaton.

Early starters

An early starter in the offset race is Hughes Aircraft Co. The maker of the AWACS' audio distribution system has assumed a $26 million offset on its $20 million AWACS contract and, according to a company spokesperson, has already placed $12 million in offset commitments with its Scottish subsidiary, Hughes Microelectronics Ltd.

One British company that stands to gain significantly from the deal is The Plessey Company Plc, a British electronics company. Prior to the signing of the AWACS agreement, Westinghouse set up its own joint venture with Plessey to explore future production possibilities. "We feel that was one of the contributing factors that helped push the [British government's] decision over the edge," says William Adams, program manager for AWACS at Westinghouse Electric Corp.'s Defense Electronics Center in Baltimore.

So far, Plessey and Westinghouse have signed a joint marketing agreement for the missile attack warning system (MAWS) that was largely developed by Plessey prior to the signing of the offset agreement, says Adams. Also, deals have been inked between Boeing and Plessey for the development of an Icelandic Air Defense System (IADS) for NATO. Neither of these agreements has progressed very far, but both will be applied to the indirect offset.

As for direct offset, the lion's share of the program is in the installation and check out (I&CO) contract and the 30-year depot contract for servicing the planes. The I&CO represents an estimated 10% of the total contract value and is expected to be awarded next month. The three contenders vying for the contract are Plessey, teamed with Ferranti Plc, Short Brothers and Racal Electronics Plc; British Aerospace; and GEC, teamed with Marconi. Westinghouse has already asked for a quote from Plessey for sending engineers to the United States for participation in the building and testing of the AWACS radar during its production cycle here, says Adams. This implies Plessey has an inside track on the I&CO contract.

IBM is negotiating offset deals for the AWACS computer and computer controls

Disappointment

While prospects for business are promising, very little has been done to date. "There is a degree of disappointment in Plessey and Britain in that [the benefits of the offset] have not been as fast as hoped," comments David Elliott, vice president of Plessey's Electronic Systems Inc., a marketing arm for Plessey in Washington, D.C. Still, Elliott is positive that programs will materialize and Boeing will come through with its 130% commitment: "We see it as a long-term relationship and want to increase the impetus with both Boeing and Westinghouse."

There are several reasons why both direct and indirect offset agreements have been slow in coming. At the top of the list is exchange rates. The value of the British pound has risen from $1.40, when the deal was signed in early 1987, to around $1.80 in April 1988, making British goods less competitive. Barkes at Boeing concedes that this change could have a negative impact on the offset because Boeing's initial offer for the planes was so competitive.

Another element causing some headaches is the speed at which the U.S. Office of Munitions grants technology transfers and license agreements for export. Boeing is committed to deliver the first AWACS in 1989 and needs to be able to share the military specifications for systems with prospective British companies. The vetting process takes 60 to 90 days which, according to both U.S. and British companies, is putting British companies at risk of missing out on the bidding process.

Adams at Westinghouse admits that Westinghouse has already had to grant subcontracts to U.S. firms over British firms because of the licensing bottleneck. The value of those contracts ranges between "tens of thousands of dollars to millions," he says.

"If I were the U.S. defense industry, faced with budget cuts like it is being faced with, the best thing that could happen would be to get the government to agree to be a bit more flexible and responsive in its licensing so it can push things through quickly," comments Roger Harding, the British Minister for Defense Materiel in Washington, D.C. Harding calls the U.S. licensing system a "painful bureaucratic process."

Looking further out, most industry experts agree that offsets will be around for a long time to come. According to the OMB study, 90% of those surveyed say offsets are just a part of doing business. But with Boeing's precedent-setting 130%, some critics claim the stage is set for other countries to demand the same rate, thus leading to the erosion of the U.S. aerospace and defense industries. Most pundits insist, however, that the circumstances of the British AWACS deal were unique and it is doubtful it will be repeated.

But it does raise the issue of how important defense-related exports are becoming to U.S. companies and highlights the lengths to which they will go to get a sale. Also, as offsets begin to have their desired effect — creating viable foreign industrial bases — the competition that U.S. firms face, both for U.S. and foreign sales, will begin to increase. And that will put the pressure on U.S. firms to make more concessions. □

Which electronics mega-deals worked — and which didn't

Full of pomp and promise, the biggest M&As in electronics haven't always worked out. Here's how readers rate eight of the largest deals of the '80s

BY NORM ALSTER

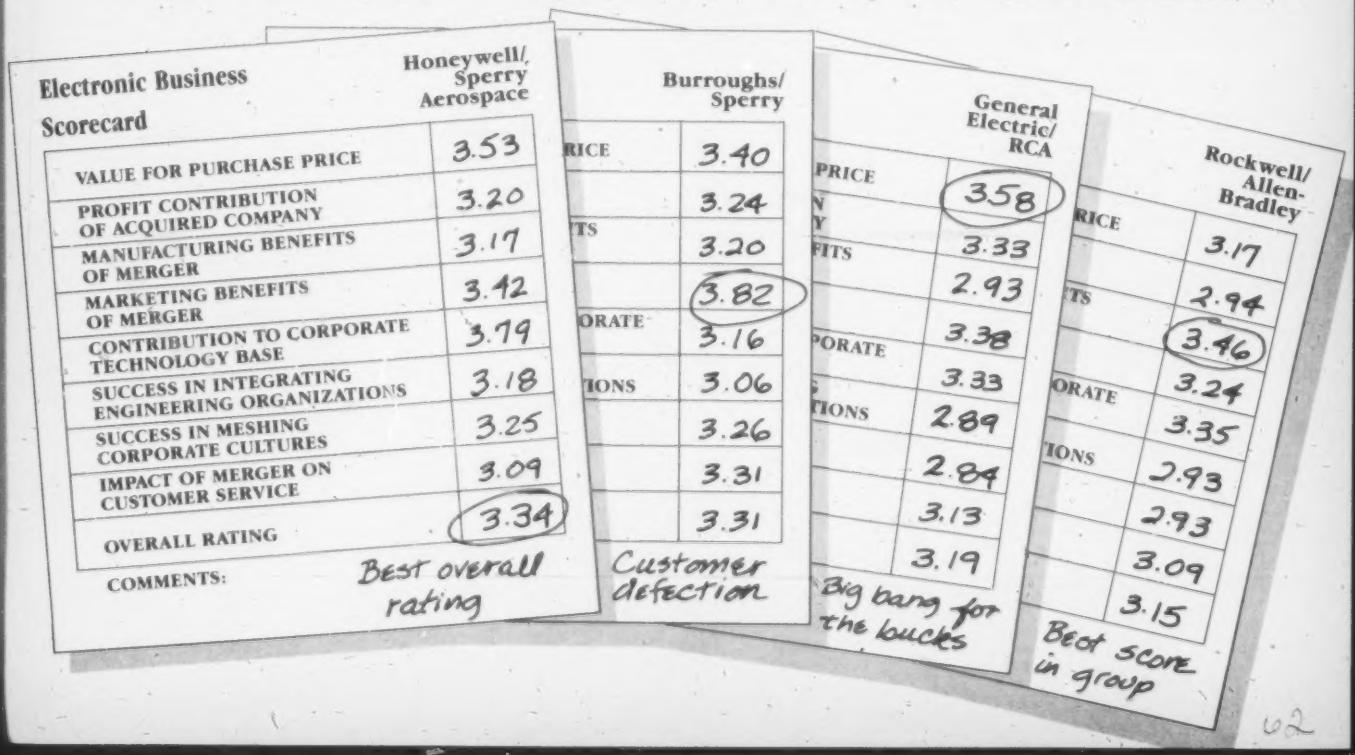
Mergers and acquisitions always generate bold headlines and reams of instant analysis. This match offers "synergy." That one insures "economies of scale" or "participation in high-growth markets." And who would dare argue with "counter-cyclical diversification?" With time, however, wholly different stories unfold: personality clashes, disappointing markets, unexpected competition, unmanageable debt, organizational mismatch, product mishmash.

Some mergers do, however, stand the test of time. To find out which of this decade's billion-dollar deals look best today, ELECTRONIC BUSINESS polled a group of 2,000 of its readers: senior executives in electronics companies plus a sampling of financial analysts. They were asked to evaluate eight of the largest acquisitions in the electronics industries during the 1980s. Among the eight criteria for evaluation were: value for purchase price; contribution to the corporate technology base; success in meshing corporate cultures; and success in integrating engineering organizations. We received exactly 100 responses.

In what was almost a dead heat, two deals were ranked well above the rest. First, by a nose, was Honeywell Inc.'s acquisition of the Sperry Aerospace Group, a deal which allowed Honeywell to strengthen its aviation business just prior to slipping out of the computer business.

Judged just a hair less favorably was a deal that actually set up the first: the $4.4 billion coupling of Burroughs Corp. and Sperry Corp. The Power of Two — now the No. 2 computer company — finished at No. 2. Actually, the success of the Burroughs/Sperry deal derives in part from the sale of its aerospace division to Honeywell. The $1 billion raised by that sale helped reduce the heavy debt burden of young Unisys Corp.

The most hapless marriage, according to survey results, featured a wealthy groom and a somewhat headstrong young bride. Physical attraction was indisputable. Indeed, some felt there was electricity in the air when IBM purchased Silicon Valley superstar Rolm Corp. But communications soon broke down. "It was like trying to fit a Rolm peg into a square hole," reckons David Kunstler, vice



president of Toqueville Asset Management Corp., an institutional money management firm.

Another deal fouled by crossed wires involved an even wealthier suitor. General Motors Corp.'s harrowing absorption of Electronic Data Systems drew the lowest scores in the survey for "success in integrating engineering organizations, success in meshing corporate cultures," and "impact of merger on customer service."

The beauty of the Sperry acquisition for Honeywell was that it greased the skids for Honeywell's exit from the computer business. "As they continued to deemphasize computers, they really needed to replace the revenues," says Howard P. Sadtler, director of investment strategy at Branch Cabell & Co. and a respondent to the survey. The acquisition of gyroscope pioneer Sperry Aerospace "strengthened an already strong Honeywell position in aerospace and defense," according to Sadtler. Honeywell was therefore able to build a new core business — now accounting for roughly half of corporate sales — as it prepared to cut the cord on its backbone business in computers.

The Burroughs/Sperry liaison is described as "a marriage made in heaven" by Sadtler. Sperry and Burroughs were each faced with shrinking computer franchises and the prospect of accelerating defections from their mainframe customer bases. The merger, reasons Sadtler, reassured customers that the new combine was in the computer business to stay.

There was, however, an unsavory aspect to the deal. Many heads rolled so that Unisys might live. Sadtler estimates that 15,000 or more Burroughs and Sperry employees were terminated. Surprising, then, that one survey respondent actually gives Unisys good grades for "managing human resources." Timothy Propeck, a vice president with Advanced Micro Devices Inc., says top management exhibited "fairmindedness" in making personnel decisions. "They laid off a lot of people. But they were real up-front," says Propek. "And they didn't favor one side over the other."

Despite its poor rating as a merger, the IBM-Rolm purchase succeeded on one count: it maintained IBM's unblemished record of failure in trying to buy its way into telecommunications. With its Satellite Business Systems spinning zeroes at a dizzying pace and with private branch exchange switch maker Mitel unable to deliver the new switch it was developing for the Armonk, New York-based computer giant, IBM turned to Rolm, one of the more glamorous addresses in Silicon Valley during the early '80s.

But the neighborhood deteriorated quickly after IBM moved in. The PBX business fizzled, as did the quixotic notion of convergent computer and communications technologies. One respondent, declining identification, says IBM "grossly overpaid" for Rolm when its business was skidding downhill. IBM may have also overpaid Rolm executives in sweetening the deal, he adds. Some key Rolm executives were so enriched they found little reason to stay after the merger. □

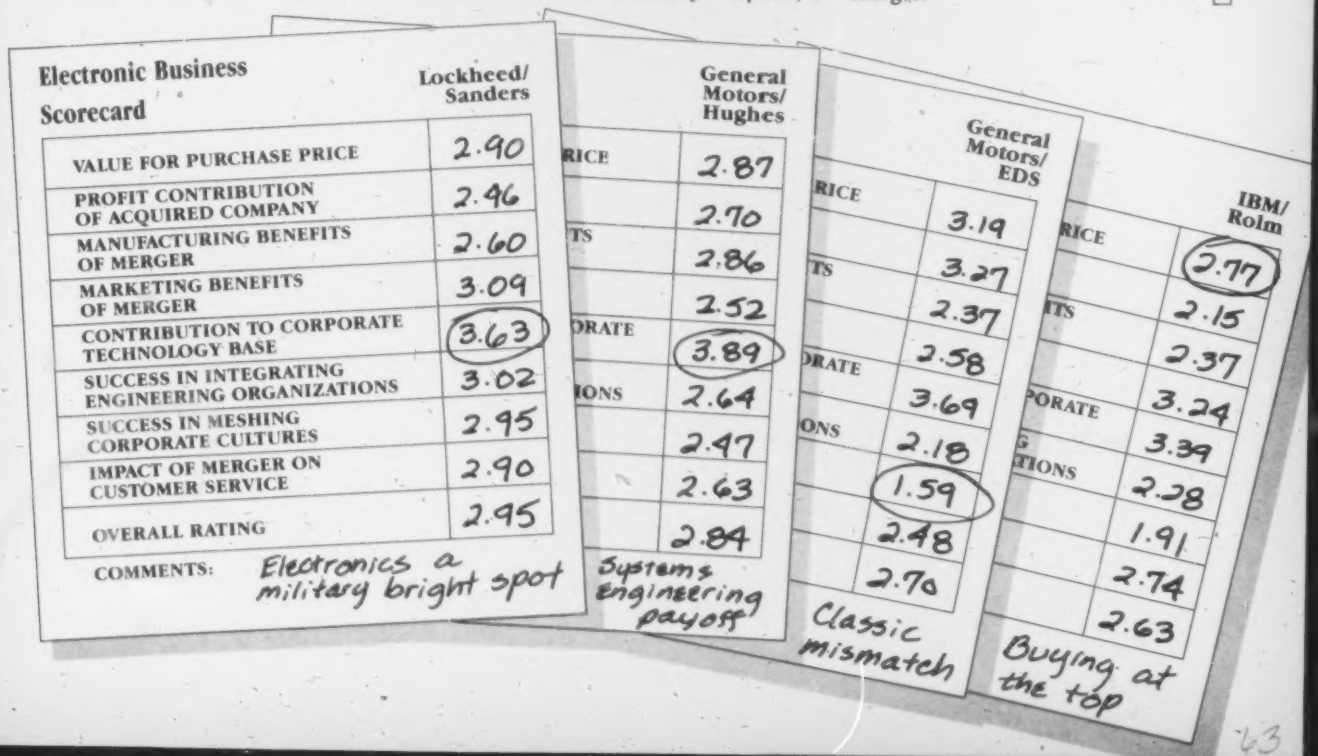
Ranking the mega-deals

A ranking of electronics industry mega-deals — from most to least successful — by the readers of ELECTRONIC BUSINESS

Value of deals ($ billions)

1. **Honeywell/Sperry Aerospace** ($1.0)
2. **Burroughs/Sperry** ($4.4)
3. **General Electric/RCA** ($6.2)
4. **Rockwell/Allen-Bradley** ($1.7)
5. **Lockheed/Sanders** ($1.2)
6. **General Motors/ Hughes** ($5.2)
7. **General Motors/EDS** ($2.5)
8. **IBM/Rolm** ($1.3)

Source: ELECTRONIC BUSINESS



Electronic Business Scorecard

	Lockheed/ Sanders	General Motors/ Hughes	General Motors/ EDS	IBM/ Rolm
VALUE FOR PURCHASE PRICE	2.90	2.87	3.19	2.77
PROFIT CONTRIBUTION OF ACQUIRED COMPANY	2.46	2.70	3.27	2.15
MANUFACTURING BENEFITS OF MERGER	2.60	2.86	2.37	2.37
MARKETING BENEFITS OF MERGER	3.09	2.52	2.58	3.24
CONTRIBUTION TO CORPORATE TECHNOLOGY BASE	3.63	3.89	3.69	3.39
SUCCESS IN INTEGRATING ENGINEERING ORGANIZATIONS	3.02	2.64	2.18	2.28
SUCCESS IN MESHING CORPORATE CULTURES	2.95	2.47	1.59	1.91
IMPACT OF MERGER ON CUSTOMER SERVICE	2.90	2.63	2.48	2.74
OVERALL RATING	2.95	2.84	2.70	2.63

COMMENTS: Electronics a military bright spot | Systems engineering payoff | Classic mismatch | Buying at the top

M&A mega-deals dominate, but mini-deals proliferate

In their search for "critical mass" and better distribution channels, smaller companies are following the mergers-and-acquisitions route too

BY ANNE KNOWLES

Mega-deals are what merger mania is all about, right? Mammoth mergers like that of Burroughs Corp. and Sperry Corp. are fueling the current mergers-and-acquisitions — or M&A — craze. Or so it seems.

It is true that so-called mega-deals like Unisys Corp. represent more M&A dollars and have the greatest impact on the industries they compete in. It is also true that M&A specialists on Wall Street fan the flames of larger deals because of the correspondingly larger fees they generate, says Harry K. Rosenthal, vice president and senior telecommunications equipment analyst at Prudential-Bache Capital Funding in New York City.

In reality, however, the majority of M&A activity is on a much smaller scale. Last year, in the information technology industry, there were 574 transactions worth nearly $10 billion altogether, according to Broadview Associates, a Fort Lee, N.J., firm that puts together and analyzes M&A deals. Only 11 of those deals, though, were valued above $200 million.

Much more common is the "mini-deal" — acquisitions ranging from Tandon Corp.'s $2.75 million purchase of Atasi Corp. to National Semiconductor Corp.'s $122 million acquisition of Schlumberger Ltd.'s Fairchild Semiconductor Corp. divestiture.

The momentum in all M&A activity is being driven by a number of factors. In addition to encouragement from the financial community, says Prudential-Bache's Rosenthal, a trend toward globalization is pushing companies, large and small, to expand their businesses through mergers and acquisitions.

A case in point is Dynatech Corp., a diversified communications supplier in Burlington, Mass. Dynatech, which had $304 million in sales last year, is a medium-sized company that has been an active buyer of other companies. The 19-year-old corporation has completed over 60 acquisitions since 1979, according to John Powers, vice president for corporate development. Powers says the company has six full-time employees, in addition to himself, in charge of researching, negotiating and completing the acquisitions.

"Diversification is a major theme" at Dynatech, says Powers. "Our strategy is to compete in small niche markets. We are not particular about which markets [the acquired companies] are in as long as they are technologically innovative and have good management."

Powers believes Dynatech has a healthy track record. Of those 60 acquisitions, Dynatech has "probably sold two companies, closed two or three small operations, merged a few and still has some that aren't doing that well," says Powers. Most of the deals, says Powers, have been negotiated through stock, rather than paid for in cash, due to accounting practices associated with cash deals that result in higher taxes. Charlie Federman, a partner with Broadview Associates, says most smaller acquisitions and mergers are completed with stock for that very reason.

While all deals are unique, says Powers, successful deals do have common attributes. One is that the acquired company must have a well-defined niche, says Powers. Another factor is a good management team already in place. Dynatech prefers to buy a company whose management has reached its financial goals and is instead motivated by achievement, says Powers. "We don't do turnarounds," says Powers. "Each division is autonomous and we depend on management to stay." For that reason, says Powers, Dynatech buys only privately held companies.

In contrast to larger deals, smaller acquisitions are almost always

M&A activity in electronics

Mergers and acquisitions in the information technology industry

	1986	1987	Percentage change
Information services and software	305	358	17%
Computer and communications hardware	127	141	11%
Telecommunications carriers	39	46	18%
Other	23	29	26%
Total transactions	494	574	16%
Total price paid* ($ billions)	$20	$10	NM**

Source: Broadview Associates

* Total price paid is an estimate. The dollar values of many transactions under $15 million are not reported

** Not meaningful—In 1986, numerous megadeals, such as Burroughs Corp.'s $4.4 billion acquisition of Sperry Corp., resulted in a large total price paid

A trend toward globalization is pushing electronics companies, large and small, to expand their businesses through mergers and acquisitions

Greg Couch

friendly, says Broadview's Federman. The companies are usually privately held. Either the acquired company's management or the venture capitalists who have backed the company are interested in being bought. The buyer, also likely to be a privately held company, may want to go public and grows through acquisition in order to attract public investors.

A driving factor specific to small acquisitions is that need to obtain "critical mass," says Prudential-Bache's Rosenthal. That gives companies the incentive to both acquire and be acquired. "There is a growing awareness among entrepreneurs that at some point they will have to sell out," Rosenthal contends. An unusual case in point is Timeplex Inc. Last year, Timeplex acquired Cygnus Computer Corp., a maker of fast packet switches, only, in turn, to be bought by Unisys Corp. "That's a case of a minnow being swallowed by a shark being swallowed by a whale," says Broadview's Federman.

The most common reason small-to medium-sized companies acquire other companies is to expand their distribution channels — an aspect of business that becomes increasingly important as the electronics, computer and communications industry move toward standards. "Innovation," says Broadview's Federman, "is not as important as distribution."

Wavetek Corp., a test and measurement firm in San Diego, bought Datron Instruments Inc., a maker of multimeters and calibrators, for $15.8 million in cash. Datron, which had moved its headquarters to the United States but was actually owned by Britain's Datron International Plc, had let expenses run too high while business was slowing down, according to Wavetek vice president for human resources Dan Sullivan. Datron, says Sullivan, needed to either restructure or put itself on the auction block. And Wavetek, with $22 million in the bank, was looking. The two companies had similiar product lines, but Wavetek wanted to expand its distribution channels in Europe.

A small company may also want or need another company's product line, either to broaden their own set of products or to put them in the technological lead in their industry. The easiest, quickest, and sometimes least-expensive way to do that is to acquire the entire company.

Adage Inc., a computer graphics terminal maker in Billerica, Mass., wanted to broaden its product line in order to enter the IBM-compatible CAD/CAM market. CGX had spent $4 million developing such a product, says Jim Norrod, president of Adage and former president of CGX. Last fall, $40 million Adage acquired CGX Corp., which had about $8 million in sales, for $16 million.

The Adage-CGX merger turned into a classic turnaround, says Norrod. And in many ways, the acquired company ended up turning around its parent. Adage had been in the red since 1985, says Norrod, while CGX was profitable. After the acquisition, Norrod remained president of CGX, as a separate division, and became a vice president of Adage. Within two months, however, Norrod put together a new business plan for the merged company and presented it to the board of directors. Norrod wanted to move more manufacturing outside of the company, consolidate the product line by reducing it from 23 products to eight, and realign the sales organization by putting more emphasis in international markets, which accounted for one-third of the company's revenue. The board accepted his proposal, elected the then-current president to chairman of the board and promoted Norrod to president of Adage.

Now CGX, according to Norrod, has the largest market share, after IBM, in the 5080 terminal emulation market. He expects the company will continue to lose money for the next few years but says Adage is on track in its business plan. And despite the fact the merged company, "has taken on a new identity," according to Norrod, CGX's influence is apparent. Adage is now run like a small company, says Norrod. It is headed by Norrod and three vice presidents, two of whom came from CGX. Before the merger, Adage had nine vice presidents. The workforce has been reduced to 320 employees, from a total of 500 from both companies, to cut costs. Manufacturing employment has been cut, but 70 of the 80 former CGX employees remain. □

Compare your company to the Japanese

Fujitsu spends 8.6% of its total sales on manufacturing labor. Hitachi spends 13.8%. What does your company spend?

BY PAULA DOE

Want to know how your firm stacks up against the fabled productivity of the Japanese? From company reports *(Yuka Shoken Hokokusho Soran)* filed with the Japanese government and recently released by the country's Ministry of Finance, figures are now available to help you make the comparison [see accompanying table]. These financial numbers, never before published in English, reveal the detailed cost structure of the Japanese electronics manufacturer, listing everything from manufacturing overhead to advertising expenses.

Four companies — Fujitsu Ltd., Hitachi Ltd., Matsushita Electric Industrial Company Ltd. and NEC Corp. — were selected as a small sampling of Japan's major electronics corporations. Except for Matsushita, the figures for the companies are for the fiscal year ending March 1987. (Similar figures for the most recent fiscal year ending last March will not be available until late this year or early next year.) Because Matsushita recently changed its fiscal year, the most current figures available for the company were for the year which ended in November 1986.

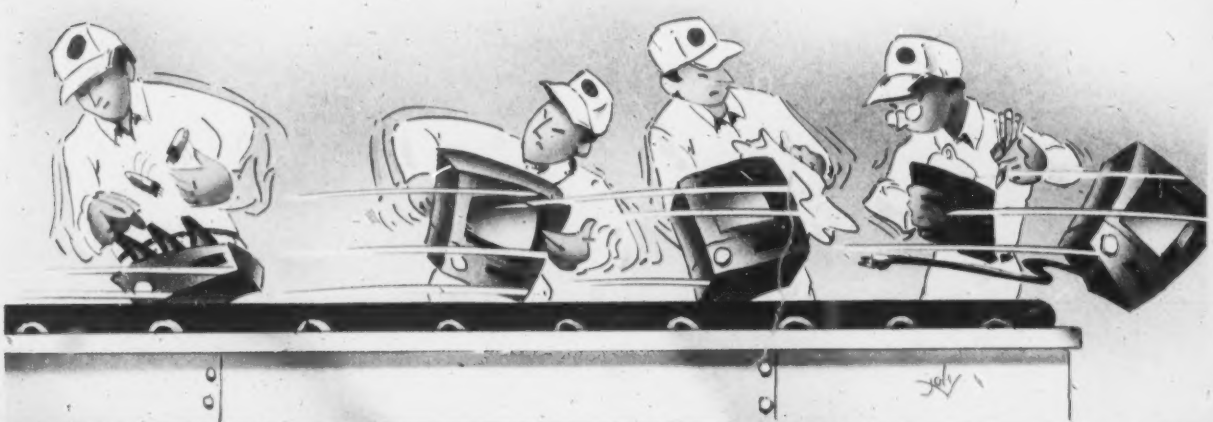
Sales per employee at the major Japanese companies remained astronomically high and the rising value of the yen puffed them up even more. Matsushita reported an astounding $541,600 revenue per employee. But these figures are for the Japanese parent company only and are not directly comparable to a U.S. company's consolidated results. The Japanese parent company keeps its own number of employees down by relying heavily on workers at subsidiaries and affiliated subcontractors.

The major Japanese producers run with lean management

Consolidating the parent's results with its subsidiaries brings the average sales per employee at the top 20 largest Japanese electronics companies down to $164,400 for 1986 [ELECTRONIC BUSINESS, Oct. 1, 1987, p.75]. Still, the comparable figure for the United States' top 20 was $94,000. Work done by other, unconsolidated Japanese affiliates probably accounts for some of the remaining difference. However, some other key differences are also notable.

The Japanese invest massive amounts of capital per worker. At NEC's Tamagawa plant, which makes integrated circuits and telecommunications transmission gear, there was $30,200 worth of capital equipment for each of the 9,068 employees for fiscal 1986 (ended in March 1987). At Hitachi's Musashi integrated circuit plant, investment other than land and buildings was $29,000 for each of the 3,756 employees. At Fujitsu's Numazu computer plant, equipment investment was $23,200 for each of the 2,547 employees.

Matsushita gets by for surprisingly less, doubtless in part because its product mix tends toward simpler



Productivity of major Japanese electronics manufacturers

	Matsushita	NEC	Hitachi	Fujitsu
1987 sales ($ billions)* **	**$21.7**	**$14.5**	**$20.0**	**$10.2**
Relative costs				
(as percent of total sales)				
Cost of sales	**82.1%**	**70.3%**	**78.6%**	**70.3%**
Cost of goods purchased	56.0%	15.0%	0.0%*	14.4%
Cost of manufacturing	23.6%	56.5%	77.7%	58.5%
Materials	17.7%	47.6%	43.1%	45.6%
Labor	3.9%	8.1%	13.8%	8.6%
Overhead	2.0%	13.9%	16.4%	2.5%
Depreciation	0.9%	3.1%	4.5%	4.2%
Materials inventory	-0.1%	0.3%	-0.1%	-1.2%
Account transfers	-0.8%	-16.3%	0.0%	-1.2%
Inventory write-down	0.0%*	-0.2%	0.0%*	0.0%*
Product inventory	0.2%	-0.9%	0.9%	0.2%
Account transfers	0.4%	0.0%*	0.0%*	-2.8%
Inventory write-downs	0.0%*	-0.3%	0.0%*	0.0%*
Sales tax	1.9%	0.0%*	0.0%*	0.0%*
Selling, general & administrative costs	**15.5%**	**26.6%**	**18.5%**	**27.7%**
Direct selling expenses	5.4%	0.0%*	0.0%*	0.0%*
Personnel	4.0%	3.0%	2.1%	7.1%
Sales promotion	1.1%	4.3%	0.0%*	0.8%
Sales commissions	0.0%*	0.0%*	0.0%*	2.2%
Advertising	0.8%	1.2%	0.8%	0.8%
Shipping	0.8%	2.2%	2.1%	1.4%
Depreciation	0.6%	0.5%	0.1%	1.9%
Rents & leases	0.5%	0.0%*	0.0%*	0.4%
Supplies	0.5%	0.0%*	0.0%*	0.0%*
Travel	0.4%	0.0%*	0.0%*	0.0%*
Communication	0.1%	0.0%*	0.0%*	0.0%*
R&D	0.0%*	8.3%	5.6%	8.1%
Other	1.3%	7.1%	7.8%	5.0%
Operating income	**2.4%**	**3.1%**	**2.9%**	**2.0%**

	Matsushita	NEC	Hitachi	Fujitsu
Productivity				
(dollar figures in thousands)				
Sales/employee	$541.6	$379.1	$256.9	$201.5
Operating income/employee	$12.7	$11.9	$7.4	$4.0
Value added/employee	$107.7	$34.7	$81.5	$58.0
Value added/dollar personnel expense	2.52	0.83	1.98	1.83
Value added/dollar investment	0.45	0.18	0.66	0.44
Other selected operating ratios				
(dollar figures in thousands)				
Manufacturing labor/ operating costs	10%	8%	14%	10%
Total personnel costs/ operating costs	20%	11%	17%	18%
Direct labor/indirect labor	2.1	3.2	3.9	2.7
Sales to related companies/ total sales**	72%	32%	44%	25%
Purchases from related companies/ total purchases**	71%	89%	99%	NA
Assets/employee	$21.3	$53.1	$37.2	$50.2
Equipment/employee	$9.6	$36.5	$27.4	$31.5
Personnel expense/employee	$42.8	$41.6	$41.1	$31.7

*may be accounted for under a different heading

**related companies include subsidiaries and affiliates

***Figures are for the parent companies only, for the fiscal year ending March 1987. (Figures for the most recent fiscal year ending last March will not be available until late this year or early next year.) The numbers do not include the financial results of each company's subsidiaries. Because Matsushita recently changed its fiscal year, its figures are for the most recent full year available, which ended in November 1986.

An exchange rate of $1 = ¥146 was used.

Source: Company reports *(Yuka Shoken Hokokusho Soran)* published by Japan's Ministry of Finance

consumer electronics products. Even at its massive Kadoma plant in Osaka, which makes office and factory automation equipment as well as video cassette recorders and audio equipment, investment other than land and buildings was only $8,700 for each of the 7,044 employees.

Running lean

The major Japanese electronics producers also run with remarkably lean management. Ratios of direct to indirect labor usually fall somewhere between 2.0 and 4.0, roughly meaning that there are 2 to 4 manufacturing blue collar workers for every white collar manager. For U.S. companies, the ratio is usually reversed; in other words, American managers outnumber the workers they are managing, according to Pittiglio, Rabin, Todd & McGrath, a Boston consulting firm.

However, the Japanese figures exaggerate the number of production workers slightly, since they include plant management as direct labor. Still, it is notable that Matsushita ran its $22 billion business with only 1,452 total employees at its corporate headquarters in 1986 — while 1,917 people worked in its research laboratories. The company employed another 7,500 in sales and administration in branch offices and 27,000 in its plants.

Despite lean management at the major Japanese electronics companies, personnel costs are still a major expense. Although some pundits argue that labor costs have become an insignificant part of manufacturing, total personnel expenses reached up to 20% of Matsushita's total operating costs. It's no wonder why Japanese manufacturers are still rushing production offshore. □

VGA boards offer a colorful future for board makers

The new graphics standard on IBM's PS/2 line has created some problems, but more opportunities, for graphic board makers

When IBM announced its Personal System/2 computer line, it created a variety of opportunities for the computer industry. One of the major opportunities was that of upgrading the performance or features of the so-called "classic bus" computers — those using the PC or AT bus — to match the capabilities of the PS/2 line.

The one area where demand from classic bus users quickly became clear, and which was thought by board makers to be relatively simple to copy, was the video graphics array specification. VGA provides higher resolution than the VGA and CGA graphic display standards of the PC XT and PC AT computers, while providing more colors — up to 256 —to be displayed on-screen simultaneously. Indeed, early versions of EGA boards were shipped less than six months after the VGA spec was described.

"VGA is pretty darned good," says Eric Shealy, product manager for graphics at Everex, in Fremont, Calif. Although the sales of EGA controller cards are still stronger than VGA cards, VGA is catching up fast, according to industry sources.

One of the reasons VGA will compete well, and quickly, with EGA as the predominant display standard for PCs comes clearly into focus when the idea of a display system comes into play.

EGA adapters produce a purely digital video signal. The adapters emulate other, lower resolution video modes by producing a slower video signal. As video resolution increases, scan frequencies and video signal frequencies also increase, allowing the higher resolution signal to be transmitted for reproduction by the monitor.

The increase in resolution has required creative solutions. One prominent solution is the so-called multiscan or multifrequency monitor. This method has been described by one industry watcher as a "brute force" approach to compatibility with the variety of graphics modes currently available. Although the multiscan monitors work, there are a number of drawbacks.

At the same time, VGA is designed to produce a purely analog signal. The analog signal is a single, fixed frequency, roughly 31.5 KHz. Compatibility with other video modes is adjusted by the board's dot clock. With lower resolution modes, such as EGA, CGA or MDA (monochrome display array), the electronics on the VGA boards reduces the number of dots sent to the monitor, while maintaining the same signal frequency.

Building a VGA analog monitor is a fairly simple task, when compared with building a multiscan monitor. Since the monitor will operate at only one scan rate, there is no need for special circuitry to adjust to other rates. And since the display uses a single frequency, the display can be optimized for maximum clarity and color definition. This adds up to a monitor that is both superior to multiscan monitors, and also less expensive to build. "Analog monitors are cheaper to manufacture," says Andy Fischer, director of operations at Hercules Computer Technology, in Berkeley, Calif. "And there are some nice clone monitors coming out," adds Fischer.

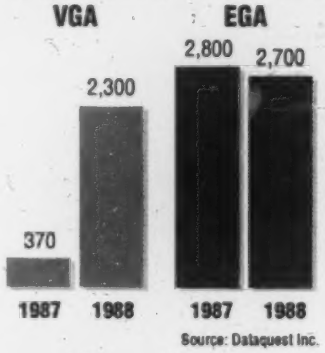
The combination of EGA card and multiscan monitor is currently running at near parity to the VGA card/VGA monitor combination. However, VGA monitor/card combinations will soon become much less expensive, and more desirable than EGA due to economies of scale that will bring down the costs of the cards and monitors.

In spite of the obvious bright future for VGA, and its apparent dominance for the next two or more years, a number of issues have arisen around VGA boards. Board makers quickly decided that, in order to compete with the IBM VGA board, which only provided VGA display modes, full downward compatibility was required. VGA emulation is a fairly simple trick when emulating just the VGA modes, and producing a single frequency, analog signal. However, the computer world is mostly equipped with TTL monitors, which the IBM card does not support, and which most potential card buyers would like to not have to replace —at least until such time as a tangible benefit is demonstrable. And the computer world is using software that runs in lower resolution modes.

Thus, board makers quickly real-

PC/AT graphics boards

Worldwide units shipments (thousands)



Source: Dataquest Inc.

Shipments of VGA graphics boards jump while shipments of older EGA boards stall

ized that, to be successful, a VGA board for PC AT bus architecture must also produce a TTL digital signal. It also must support EGA, CGA, and MDA display modes, and not require the card buyer to replace his or her monitor to use the board. At least, not until software requiring a better monitor becomes available.

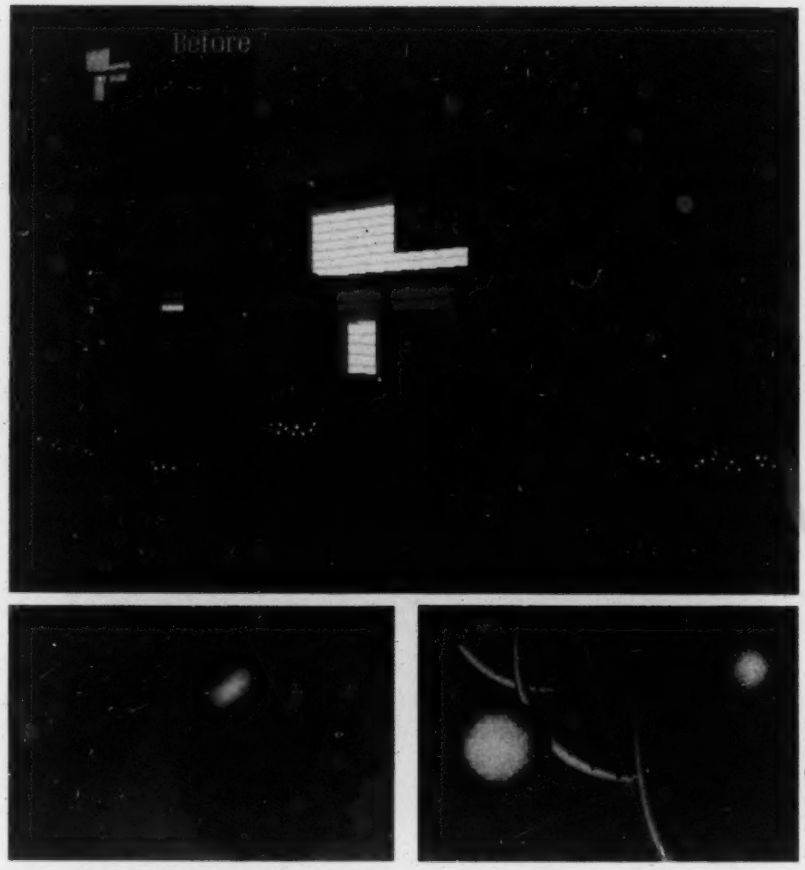
Compatibility with all modes became a stumbling block that a few companies actually tripped over. Initial VGA board shipments boasted BIOS level compatibility with all modes. However, problems were encountered with software that bypasses BIOS and writes directly to registers. Such software rather rapidly showed up incompatibilities inherent in these "100% compatible" VGA adapter cards.

A second generation of VGA boards has been developed, promising register-level compatibility. "It is important to be as register level compatible as you can be. If you're not, it can lead into problems," says Everex's Shealy. "The question of compatibility only becomes an issue if software doesn't run [on the board]," opines Hercules' Fischer. "BIOS level is fine in an ideal world," continues Fischer, "but this isn't an ideal world. I'd like to raise the level of debate regarding register level compatibility and BIOS level compatibility and what is best."

IBM has included some undocumented registers to its own VGA circuitry. Reverse engineering the VGA has revealed those registers to the board makers. There is some speculation that IBM's version of OS/2, the operating system developed for PS/2, will make functional calls to those undocumented registers as a test for a "true IBM" VGA board, thus rendering clone boards incompatible.

"IBM has the ability to throw a monkey wrench in by doing something that nobody else does," says Shealy. "It is a potential threat that can be overcome, but will cause us to do some scrambling."

Craig Lynar, vice president for marketing at Orchid Technology, in Fremont, Calif., doesn't see the undocumented registers as posing a potential trap. "IBM would be foolish to use them (the registers) if they are not documented. They need to get PS/2 off the ground. The corporate world is still leery about PS/2, and if IBM changes its video after one year, the corporate world will be behind again. IBM will most likely follow the standard specs that they've already published," believes Lynar.



The Imagery Group

VGA provides higher resolution than standard graphics modes available on PCs and is capable of displaying up to 256 colors

Another issue relates to the Video Adapter Connector, a jack that is built into PS/2 computers and is expected to allow special graphics modes to be produced. Hercules, for example, is developing an adapter board that would connect to the video adapter jack and allow the use of RAMFONTS, character fonts that are produced by RAM on the board, and are said to be much faster to create than those using standard video boards. IBM's 8514A board works in conjunction with the connector to produce higher resolution VGA graphics.

But, in spite of development efforts that make use of the adapter jack, the jack "will be a curiosity," admits Fischer. "The industry has always mimicked what IBM has done for fear that if it didn't, it would run into problems," says Shealy.

"The feature connector on the EGA board was never exploited with a real mass market product," says Fischer. "But IBM made more facilities available on the VGA card [than they did on the EGA]. A lot of things can be done [through the adapter]," he adds.

Speed is also an issue. One approach taken by Video Seven Inc., in Fremont, Calif., is the use of video RAM instead of dynamic RAM for display memory. "As the industry moves into high-end machines, '386 machines, the slowness of graphics boards becomes more pronounced and more apparent," according to Shealy. "One of the ways to get around this is to move to VRAMs. VRAMs have built-in shift registers that do the conversion for you. Basically, this speeds up the access time to RAM — that's increased performance." But VRAM is currently quite expensive, and not easy to find. "Cards with VRAM will be priced much higher than other VGA boards," says Lynar. "It [using VRAM] is a valid approach to addressing the video bottleneck problem," says Fischer. □

ECL vs. GaAs chips: Let the clock-speed games begin

Brisk new bipolar designs are catching on. But are they enough to keep GaAs advances at bay? Most speed-hungry users have no doubts

BY VALERIE RICE

The market for very fast logic chips, once confined to esoteric computer systems in the form of TTL chips, has expanded dramatically in recent years to embrace new process technologies — like bipolar ECL and the "alternative" technology gallium arsenide (GaAs) — as well as new customers.

The reasons? Technology marches on, and advances in emitter-coupled logic, including improved density and lower power dissipation; and in digital GaAs, which has been proven to be commercially viable in some applications; have made believers out of skeptics.

Now a new market of speed-hungry users awaits suppliers of these very fast chips, giving breaks to brash start-ups and forcing old-line chip makers and their equipment suppliers to rethink their strategies. And it's a market that could favor U.S. over Japanese suppliers as users like Scientific Computer Systems Inc., fearing dependence on Japanese "competitors," brag about the all-American content of their high-performance systems.

But do those users opt for bipolar? Or are they seduced by new GaAs designs? Despite much warring talk, most of it from GaAs suppliers, there's little contest. GaAs, still wrestling yield, pricing and second-sourcing problems, remains attractive chiefly for applications where speed is the foremost feature. For all other speedsters, ECL does fine.

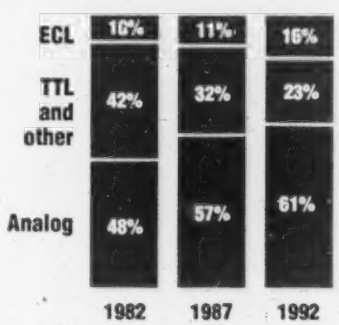
But both ECL and GaAs sectors are teeming with activity. The best example of that activity is the number of start-up companies appearing over the last few years. At least four bipolar start-ups have been founded during the past five years. And 20 GaAs start-ups were begun in the period from 1978 to 1985, according to a study by market research firm Dataquest Inc.

Even the customer base has changed. GaAs, which is so well suited for military markets that it runs the risk of being typecast, has finally clawed its way into the commercial market — and the digital market — it is 100% of the logic in Cray Research Inc.'s latest system, the Cray 3. Bipolar ECL has also found its way out of the old Cray 1, where it was first used, and into very high-end workstations that actually sit on a desktop. Two years ago, that was unheard of.

Gallium gains notwithstanding, silicon lovers can rest assured, at least for awhile. Digital GaAs has a ways to go before it can overtake bipolar ECL.

Bipolar technology trends

Share of bipolar IC market



Total bipolar IC market ($ billions)

$4.6	$10.7	$15

Source: Integrated Circuit Engineering Corp.

ECL's share of the bipolar business is growing as TTL technology is chased by CMOS ASICs

Data from market research firm Integrated Circuit Engineering Inc. shows that the 1987 bipolar market was worth $10.7 billion, of which ECL represented 11%, or roughly $1 billion. The bipolar market is forecast to grow to $15 billion by 1992, with the ECL share increasing to 16%.

In contrast, digital GaAs was only a $35 million market in 1987, according to ICE. It is expected to show hearty growth, however. ICE forecasts the 1992 market to be about $600 million for digital GaAs.

Depending on who's speaking, bipolar versus GaAs is an either/or situation. Soothsayers predict the technologies will learn to peacefully coexist, with each finding its appropriate niche. Naysayers, on the other hand, expect one technology or the other to be obliterated, again depending on who is speaking.

So could GaAs be a real threat to ECL?

Perhaps, says ICE's market research manager William McLean, but it is unlikely to take a big chunk away from the bipolar. "There's been a lot of work in the ECL area," he says. "All the experience, time and effort that has been put into ECL dwarfs GaAs."

GaAs technology has not advanced that quickly, he says, and he does not see a breakthrough on the horizon that will rescue it from its high cost.

No competition

Start-up Bipolar Integrated Technology Inc.'s marketing vice president, Les Soltesz, says definitely "we do not see any sort of competition whatsoever from GaAs. Our application base is made up of companies pushing the state of the art of integration, putting more on a single chip. GaAs can't provide that."

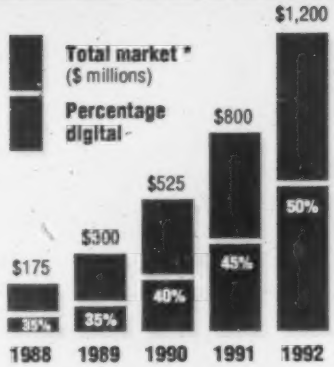
But the GaAs proponents are

equally sure that they can beat ECL at its own game. Or at least start-up Vitesse Semiconductor Corp. says it can.

Vitesse claims that its strategy is to offer users pin-compatible GaAs parts, both gate arrays and standard products, that are equal in price to ECL; equal or better in speed; and have much lower power dissipation. This puts Vitesse directly in competition with giants Motorola Inc. and Hitachi Ltd., as well as start-ups like BIT. But Vitesse executives say that doesn't scare them one bit.

The most likely technical hitches to Vitesse's plans revolve around yield and interconnect issues. One of the largest challenges in digital GaAs has been achieving production yields comparable to those obtained with silicon. The other challenge, experts say, is that while GaAs in a single chip is very fast, GaAs in a gate array above 10,000 gates or so can be slower than bipolar. The high amount of interconnect necessary to link 10,000 gates together slows GaAs down more than bipolar, experts say.

Worldwide GaAs market



* Includes development funding

Source: Integrated Circuit Engineering Corp.

GaAsing up: Twenty GaAs start-ups were founded from 1978 to 1985, and the results are starting to show

Other GaAs companies, like Gigabit Logic Inc., do not claim to be on a collision course with ECL manufacturers. "We can coexist," marketing and sales vice president James Brye claims. "GaAs belongs in a performance niche."

Brye sees GaAs going into two different areas. One is applications that require "blazing speed," described as more speed than can be achieved from using silicon. In those cases, "GaAs technology will displace ECL," he says. The other area is where GaAs can do certain functions that will be "forever out of the scope of bipolar," such as one- or two-gigahertz products for telecommunications.

Triquint Semiconductor Inc. is another GaAs start-up; actually a captive operation for instrument giant Tektronix Inc. that was taken merchant several years ago. Marketing manager Louis Pengue agrees with Brye that GaAs can live in harmony with ECL. "We will replace the ECL bottlenecks, " he says. "One or two chips primarily and the rest will be ECL, especially if they are high volume, jelly bean type parts. I see GaAs as a niche market. There is no way we will push out ECL."

Perhaps the most interesting view of the bipolar-versus-GaAs debate comes from a man who straddles all three fences: bipolar, GaAs and CMOS. T.J. Rodgers, head of CMOS-based Cypress Semiconductor Corp.,

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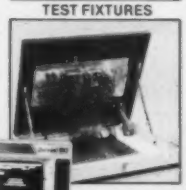

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is also acting president of his bipolar spin-off Aspen Semiconductor Corp., as well as on the board of Vitesse.

"There's no conflict of interest here," Rodgers claims. "In bipolar, I steer them away from making something that could be made out of CMOS, because the CMOS part will prevail. But in some areas bipolar is outperforming CMOS. It has a current advantage that is scalable and maintainable, and you can receive a premium for your effort. GaAs, on the other hand, can do many things ECL can't touch, such as high-frequency telecommunications or military applications. The yields are as good in GaAs, but we have to focus where we have an overwhelming advantage."

Rodgers warns that GaAs won't take business away from identical bipolar parts with the same margins.

In the bipolar ECL market where a handful of large companies own 70% of the market, do start-ups have a chance?

Certainly, claim the start-ups, and old-time start-up BIT may be proof. The company has major design wins with Sun Microsystems Inc., Alliant and Apollo Computer Inc., Soltesz claims, and says the company is living proof that bipolar isn't dead.

But although Soltesz is justifiably proud of his large customers, there are some customers who might be more leery of doing business with a start-up. One supercomputer manufacturer that evaluated BIT as a supplier questions that company's ability to supply sufficient parts, says a manager who preferred not to be named.

And Sun Microsystems' microprocessor marketing manager, Steve Diamond, says that his company is open to hearing from other bipolar companies who would be interested in licensing Sun's Sparc RISC chip architecture, something which could put a dent in BIT's sales.

Clearly, the concerns surrounding doing business with a start-up aren't unique to BIT.

For many chip users, speed is everything. Convex Computer Corp., for example, recently switched from using TTL to ECL, because the ECL parts gave the company faster clock rates and higher densities, says engineering vice president and cofounder Steve Wallach.

Wallach adds that designing with ECL makes it easier in the future to switch to GaAs. But he cautions that GaAs has a long road to travel before it can be truly competitive with ECL. Density problems and high cost, coupled with a real lack of second sourcing, make it a difficult choice today unless, as he says, "you're a company like Cray Research."

Cray went with GaAs in its Cray 3, a spokesman says, mostly because super-designer Seymour Cray felt that there wasn't too much power left in silicon. All of the logic in the Cray 3 is GaAs, the spokesman says, although he notes that the company's new machine, the Y-MP, which is ECL-based, has not reached the limits of ECL technology.

Sun seems determined to cover all the technology bases, according to Diamond. The company is currently evaluating GaAs as a possible medium for its Sparc architecture. □

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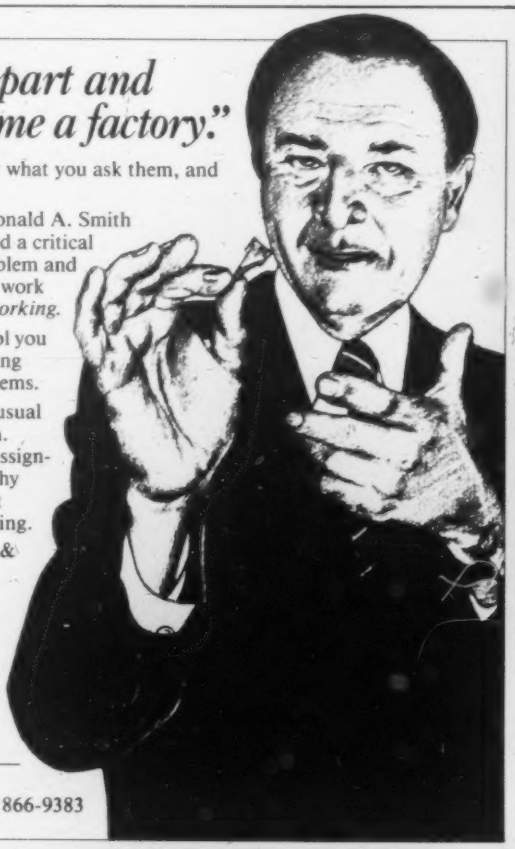

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Resistive components: Not so lonely, not too lowly

Guess where the leading manufacturer of resistors is located. In the Far East? Guess again

It sounds next to impossible for a United States-based manufacturer to be first in any segment of the components market. After all, as recently as 1984, Texas Instruments Inc. was No. 1 in semiconductors. Since then, it has relinquished the prime position to Nippon Electric Co. Semiconductors are only the most recent example of a trend that started long ago with passive components. So, it must be very difficult for U.S. makers of that most humble of passives, the lowly resistor, to be first. Right?

Wrong. Bourns Inc. is the largest maker of resistive trimmers in the world, a feat that places the Riverside, Calif., company automatically as the No. 1 maker of variable resistors. And Bourns is not alone. Vishay Intertechnology Inc., of Malvern, Pa., is first in fixed resistors. But, since Vishay sells more resistive components than Bourns does, it can also claim the No. 1 spot for resistors in the United States — and probably the world.

Vishay's president, Felix Zandman, does not overtly make such claims for the company he founded 27 years ago. So one adds $75 million in 1987 sales worldwide by the recently acquired film resistor operations from Corning Glass Works; plus $130 million in film resistors and networks from half-owned Dale Electronics, which becomes wholly owned as of next month; to Vishay's own $25 million worth of high-precision foil resistors. This amounts to a total of $230 million, all in fixed resistors.

What vaulted Vishay to the top are the acquisitions and divestitures that have taken place in this market. This marks quite a change from the days when, riding on the dominance of its fixed composition resistors, Allen-Bradley Co. was the undisputed leader. But AB is still perceived as the leading brand among our readers, according to the latest study of brand awareness and brand preference by ELECTRONIC BUSINESS magazine. The reason may be that, even though AB is now a subsidiary of Rockwell International Corp., it retains its identity in components. Dale Electronics, formerly a Lionel company and now part of Vishay, tied with Bourns for second place in brand preference. But other manufacturers have not been so fortunate. International Resistive Company Inc.'s brand image in our study is split between its former owner TRW Inc., and the "new" old name it had before TRW bought it, even though IRC is now part of a larger entity in resistors, namely Crystalate Holdings Plc.

Consolidation in the resistor market has helped the distributor, says Avnet Electronic Marketing Group chairman Tony Hamilton. More than 30% of resistor sales go through industrial distribution. Hamilton thinks that resistor sales by distribution will grow 10% in 1988. Zandman has the same forecast for Vishay's sales. So far, he has been conservative.

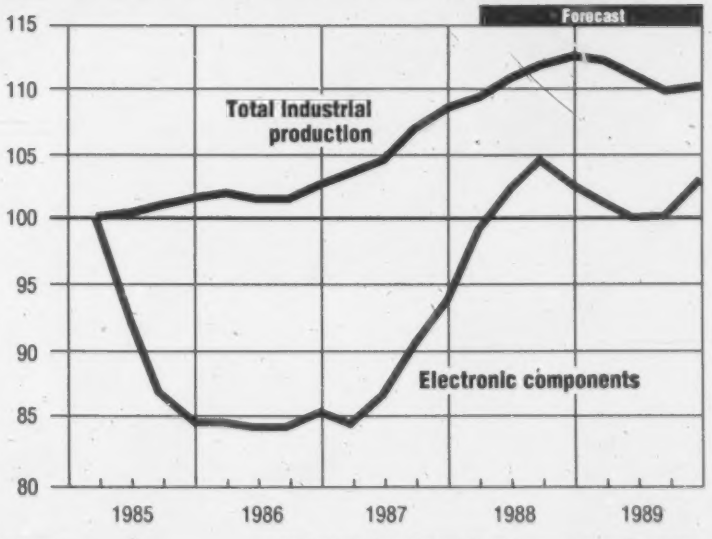
The Electronic Industries Association reports that U.S. factory sales of components of all types, active and passive, jumped 23% in the first quarter of this year versus a year ago. Most of the credit for that increase goes to semiconductor sales which, according to the Semiconductor Industry Association, grew by almost 30% in the same quarter. This still leaves enough room for components other than semiconductors to have enjoyed a healthy increase in sales. The SIA expects that U.S. sales will end 1988 ahead of 1987 by 26%, and many passive components manufacturers hope to do almost as well.

Based on the Federal Reserve Board's figures for the U.S. production (instead of sales) of components of all types, which show an increase of 17% for the first quarter, Cahners' senior economist Elizabeth Baatz forecasts a slight easing to 15% for the whole year, followed by no production growth in 1989. About two-thirds of Vishay's resistive components production is in this country, but Zandman makes no forecast for next year. "My crystal ball doesn't extend that far," he says.

ALBERTO SOCOLOVSKY

Electronic component production index

Quarterly averages, 1st quarter 1985 = 100, seasonally adjusted



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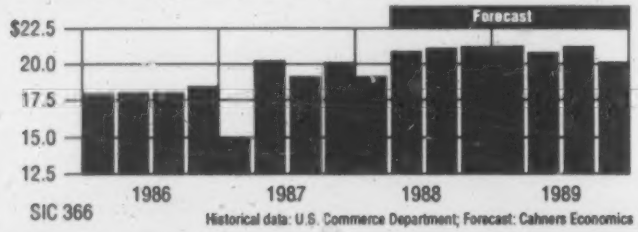
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Communication equipment — New orders

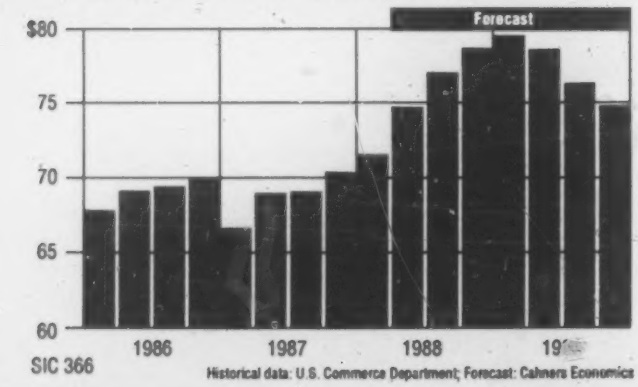
Quarterly totals, seasonally adjusted ($ billions)



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Unfilled orders

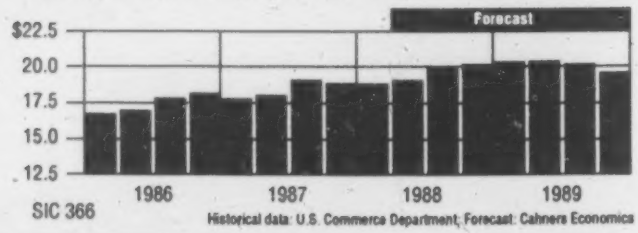
End-of-quarter totals, seasonally adjusted ($ billions)



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Shipments

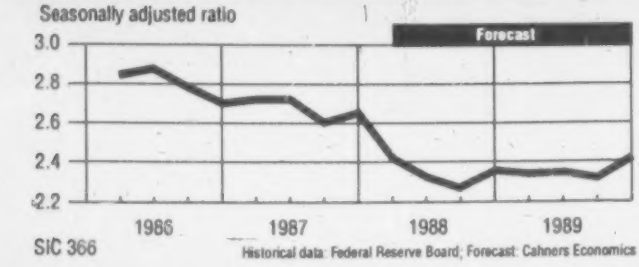
Quarterly totals, seasonally adjusted ($ billions)



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Inventory-to-shipments

Seasonally adjusted ratio



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Communication equipment slows

Unlike the rest of the electronics market, communication equipment manufacturers face an entirely unique set of circumstances in 1988. One reason this is so: almost half of all communication equipment shipped from U.S. factories last year was sent to the defense department. In 1980, less than a third of all communication equipment shipped was classified as "defense."

The upshot? With such a heavy reliance on the defense budget, communication equipment makers are bound to suffer from a slowdown in growth. Defense procurement budgets are projected to fall at least 1.4% in the 1988 fiscal year under the administration's current budget. And that decline doesn't even take into account the shrinking budget due to inflation.

In 1987, defense orders for communication equipment fell 4% on the heels of an 11% drop in 1986. Commercial orders have fared better, growing 7% in 1987 and 2% the year before.

Early evidence for 1988 shows a weak recovery. New orders for all communication equipment fell 5% from the fourth quarter of 1987 to the first quarter of 1988. But the strong upturn in new orders at the end of last year means this decline is relatively modest; new orders remain 28% above year-ago levels. Shipments, however, remained flat.

Of all the statistics reported on the communication equipment industry by the U.S. Commerce Department, perhaps the most disturbing is backlogs. Ever since mid-1985, the rate of growth of backlogs has been steadily and noticeably slowing down. Backlogs grew at a 25% rate in mid-1985, slowed to 9% growth by the end of 1986, and inched up only 0.2% by the end of last year.

Offsetting the disturbing trends in backlogs, communication equipment manufacturers have been doing a great job of keeping inventory in control. Inventory-to-shipments ratios for this industry plummeted to 2.55 last December, the lowest since 1979. Early evidence for 1988 shows inventory rising faster than shipments, but critical imbalances are unlikely.

A slowdown in backlogs is probably hitting defense manufacturers hardest. As production eats away at those healthy backlogs, a production cutback in 1989 is probable.

As defense demand withers, Cahners Economics' forecast for communication equipment depends largely on a rebound in commercial orders. Orders are projected to grow 10.6% in 1988 and fall 0.2% in 1989. Shipments are expected to rise 5.6% this year and 3.2% next year.

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SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JULY 1, 1988

Is there a RECESSION AHEAD?
Forecasting the economy through 1989 PAGE 24

How wafer-fab shortages are hurting chip makers PAGE 16

Sending the salesforce back to school PAGE 62

Lester Thurow, MIT economist

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES – WORLDWIDE

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24 How to cope with the next recession

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Cover photo: Dave Bradley

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What recession?

Is there a recession ahead? It depends on who you talk to.

Lester Thurow, dean of the School of Management at the Massachusetts Institute of Technology, is bullish on the economy. Ravi Batra, author of *The Great Depression of 1990*, is decidedly not.

Who's right? We're not sure, but we tend to be perennial optimists at ELECTRONIC BUSINESS, so we put Thurow on the cover and relegated Batra to the inside pages. Besides, most of the people whom we talk to every day are optimistic, too. And if you can't believe your friends, who can you believe?

Thurow and Batra, boom and gloom

Count those beans

Just to be on the safe side, though, we recently sent out a questionnaire to 700 chief financial officers, vice presidents for finance and controllers in the electronics industry. Altogether, 99 responded, for a highly respectable response rate of 14.1%. The results — which are published in this issue — are worth examining.

What we like about this survey — and we do it every year — is that CFOs tend to be a conservative lot. Unlike CEOs, who get paid to be bullish, CFOs rarely make outlandish claims about their companies. They're paid to count beans. And they're not going to count beans if there are no beans to count.

That's why if most CFOs polled see modest growth in the year ahead, we believe them. And if they see the economy slowing, but not disastrously so, in 1989, we believe them about that, as well.

The CFO survey, the interviews with Thurow and Batra, and the introductory article to our "Midyear Update" were provided by associate editor Bruce Rayner. The statistical data on the various segments that make up the electronics industry were compiled by contributing editor Lin Sun.

There's a wealth of economic and financial information in this edition. We hope you find it useful.

AL FURST, Editor

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VBPA ABP

WORMware

I enjoyed reading your very informative article on the subject of WORM [write-once, read many times] devices and optical drives. You noted several companies such as FileNet and Laser Magnetic Storage International, but Data/Ware Development in San Diego was not mentioned.

Data/Ware's Mainframe Optical Storage Transport (MOST) provides optical storage while emulating a 3480 emulation with an order of magnitude increase in storage.

MOST fits applications where large amounts of data or permanent value are required to be on line. Access to a virtual tape is measured in seconds. This is all accomplished in a fraction of the floor space required by other technologies. The MOST system is the optical equivalent of an IBM 3480, one A22 and one B22, but much more cost effective on a dollars/megabyte basis. Fully automatic jukebox systems are also available.

KENYON R. CRUDEN
Vice President
Peripheral Systems
Data/Ware Development Inc.
San Diego, Calif.

We're unique, too

In response to your article on Sybase Inc. of Jan. 15, 1988, [which states that Sybase, a Berkeley, Calif., software company, uniquely offers referential integrity and two-phase commit on its relational database management systems], we have identified 22 features that are unique to Empress and aren't available from the competition. None of our competitors offer these advantages to the RDBMS user.

We define our main competition in the market as being: Oracle, Informix, Unify, Ingres and Sybase. It's interesting to note that [nearly] all of these competitors recently bid on a very major computerization project being undertaken by Treasure Chest, of Glendora, Calif., the leading publisher of color inserts in the world. The project represents one of the largest commercial Unix applications and Empress was chosen as the RDBMS.

You might wonder, if we're so good, why do we have a low profile? Empress Software Inc., formerly called Rhodnius Inc., is a very young company that is just beginning to develop a recognizable presence in the end-user market. The company originated in 1979 when myself and Ivor Ladd, now vice president of technology for Empress, decided to commercialize work we had done as graduate students with the Database Research Group at the University of Toronto.

Our first Empress product was shipped in 1981. In the early years we sold mainly to OEMs, systems developers and integrators. With the introduction of products into the VMS and DOS markets in 1986, we began to focus on the end-user market. Our major clients in the U.S. include: Boeing, Auto-trol, Singer-Link, Westinghouse, Ford Aerospace and the Jet Propulsion Laboratories.

Calling ourselves the world's most advanced RDBMS is not marketing hype. We stand by our claim.

JOHN KORNATOWSKI
President
Empress Software Inc.
Toronto, Canada

We're swift

I found your magazine's new format a meaningful improvement upon an already excellent standard. Information has been presented in a more accessible fashion, without compromises on the quality and depth of your editorial content.

I believe one oversight was made in the list of the 100 fastest growing companies compiled in the May 1, 1988 issue. With 23.8% sales growth and 41.9% growth in net income over the past five years, Diceon Electronics would rank as the fastest growing company in the components segment. On the overall ranking of 100 companies, Diceon (fiscal 1987 revenue of $111.1 million) would rank 55th.

EDWARD B. KEANEY
Burns Pauli & Co. Inc.
Institutional Securities
St. Louis, Mo.

It's in the cards

We read with keen interest your article entitled "Memories are made of . . . tough little cassette cards," on page 43 of your April 1, 1988 issue.

In the article it says that Du Pont claims to be the only U.S. company to market the cards. We would like to correct that. ITT Cannon has had a major program underway in the U.S. for the last year and a half.

W.J. CLARK
Director, New Product Development
ITT Cannon Components Division
Fountain Valley, Calif.

Clarification

Oops! SMT production-equipment makers aren't **that** flush with orders

Regarding our April 15, 1988, story entitled: "These are glory days for SMT production gear firms," SMT equipment execs might wish that it were so, but U.S. consumption won't be 377 million units this year, as we mistakenly stated. The chart on page 78 was wrongly labeled. Instead of "millions of units," it should have read "millions of dollars," as indicated correctly in the text of the story. Our apologies to our source, Technology Forecasters.

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers. If not written on organizational letterhead, all letters must include a telephone number. ELECTRONIC BUSINESS reserves the right to edit letters.

ELECTRONIC BUSINESS
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Newton, Mass. 02158

Chip makers tell DOD: Let us sell rad-hard chips overseas

Harris and others claim the DOD ban on foreign sales of rad-hard chips shuts them out of Europe's satellite boom

Makers of radiation-hardened chips are fighting mad and they aren't going to take it anymore.

What they're not going to take is a 3-year-old ban on exports that does not allow chips that withstand more than 100,000 rads (a measure of radiation) to be shipped overseas. These chips are not necessarily for direct military application: they are primarily targeted at European communications satellite programs, a market that was worth $100 million to semiconductor vendors in 1987, according to market researcher Dataquest Inc., and which may now be out of reach for many vendors.

A task group will meet this month to debate the rad-hard issue, and then plans to present the Department of Defense — the source of the restriction — with a "white paper" offering suggestions for change. The team — officially the 13.4 subcommittee of the Joint Electronic Device Engineering Committee (JEDEC), a group sponsored by the Electronic Industries Association with military chip standards as one of its main charters — will review options that include case by case analysis of the security status of the countries to which rad-hard chips are sold; and case by case studies of the products themselves.

Change is needed, claim task group members from Harris Corp., Intel Corp., National Semiconductor Corp. and others, because the United States is losing money, market share and friends by imposing an "arbitrary" ban based on radiation hardness rather than on other criteria.

The intent of this ban, according to the DOD, is to keep technology critical to the United States from reaching "enemy" or non-friendly hands.

"Russia doesn't have to do any research and engineering if they can buy it," charges DOD engineer Sid Mason, a spokesman on rad-hard policy issues. "It's their modus operandi. Diversions are going on all the time. What will it do to the U.S. technology lead?"

But task group members say that a ban based on radiation hardness levels protects the wrong technology.

"This [ban] is not a way to keep technology safe," contends Joe Tirado, manager of business development for military and high-reliability programs for Harris. Tirado, a JEDEC committee member, is authoring the white paper on the subject. "This is not a radiation issue. It's a technology issue," he argues.

Making no sense

Using radiation hardness as a guideline "is not preventing critical technology from going overseas," Tirado says. "Bipolar devices are inherently rad-hard, and because of that, you can't ship devices that are 10 years old. You couldn't ship vacuum tubes based on that criteria. It makes no sense."

Another task group member, who requested anonymity, notes that many of the parts banned by the DOD are available outside the United States from other sources. "It doesn't do the security of this country any good to not make them available from here," he says.

The DOD, however, has its own view of the situation. "I hear what they're saying," says DOD engineer Mason, "but in reality their view is parochial. Who would want to use bipolar devices on a satellite? It takes too much power. That argument is moot."

Mason also argues that the communications satellite market only requires radiation hardness levels of between 30,000 rads and 50,000 rads, so the 100,000 rads ban is actually "generous."

"All we're asking is that these companies live with this restriction," Mason says, "and many have. Harris has lived with it." In fact, since 1985, Mason says the DOD has received "several hundred" export license applications to sell into the communications satellite market.

One reason semiconductor vendors are agitating for change in this policy is the relative growth of the European aerospace market, which could account for 30% of the total consumption of chips for satellites by 1991, according to Dataquest. With the U.S. space program set back significantly, semiconductor suppliers are trying to reach offshore sources with their technology.

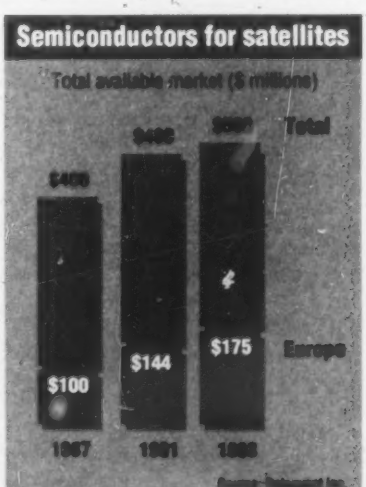
But often they are prevented from reaching these offshore sources. Under this ban, Tirado estimates that Harris has lost $10 million over the past three years.

And that is not the only negative impact. "The DOD believes in keeping the hottest technology to ourselves, and they are ignoring the fact that the Japanese could come in and take over," says Dataquest analyst Greg Sheppard. "They [the DOD] don't care," he says.

And thanks to this ban, the Europeans are moving in on this market as well, Sheppard notes. "The Europeans are trying to take away business in the communications satellite market."

So does the JEDEC subcommittee have a chance for success? Market watcher Sheppard, although he supports the effort, is dubious. "It's going to have to come from the top," he says. "The DOD doesn't stick its neck out."

VALERIE RICE



Europe's satellite-chip market is growing fast, but U.S. chip makers say the Pentagon locks them out of it

West Germany welcomes U.S. telecom gear

Germany is quickly deregulating its telecom sector — and inviting bids from U.S. modem, switch and phone makers

The "auslanders need not apply" signs are coming down all over Germany. Foreign electronics companies are discovering that the doors to the once-closed West German telecommunications market are beginning to open — at least a crack.

What this means short-range is that U.S. electronics companies will be able to sell equipment — such as switches, mobile radios and radio pagers — to the Deutsche Bundespost, the West German postal and telecommunications authority.

Longer term, Bundespost officials promise that many other barriers which have restricted foreign firms in the German market will be lifted, thus giving a considerable boost to U.S. telecommunications exports to West Germany.

Chancellor Helmut Kohl's goverment is embarking on an effort to convince foreigners that it is serious about deregulating its telecommunications markets. At the same time, however, some analysts note that the measures announced so far are limited in scope and are largely targeted to new services which don't bring in revenue for the Bundespost.

The deregulatory moves come amidst a backdrop of plans by the European Economic Community to move toward a single unified market by 1992, harmonizing policies, practices and laws in a wide variety of areas. The Community's executive commission is in the process of clearing measures aimed at reducing the monopoly powers of the telecommunications companies in Europe. Throughout the Common Market, controls will ease on sales of telephone sets, modems and other telecom equipment. New markets, like electronic mail, are likely to develop rapidly.

But according to many analysts, progress will be painfully slow in liberalizing the basic telephone setup itself, because it's a big money maker for the various governments in the EEC. In Germany alone, the state-owned Bundespost kicks in more than $3 billion annually in revenue to the federal government. So, it isn't surprising that government officials have tended to view outside competition somewhat cautiously.

Caution sums up the attitude of U.S. executives on the potential of the German market as well. Veronica Haggart, a vice president and a key Washington lobbyist for Motorola Inc., describes the German moves as "very encouraging," especially in the

Color by

Watch Apple's new Macintosh II do for color computing what the original Macintosh did for black & white. Our RAMDAC enables Macintosh II to display some of the finest quality graphics available in a personal computer.

mobile radio field.

"But it's still too early to judge the potential long-range effect of the action," adds Haggart, a former member of the International Trade Commission. "We just don't have enough information on how they plan to implement these changes to know if it'll bring any real bonanza for American telecommunication companies in general," she notes.

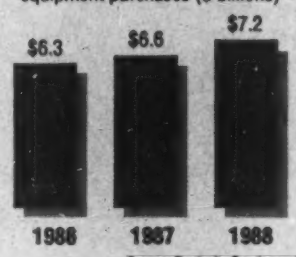
Motorola is gearing up for more activity in the European market, company officials say. They cite the purchase of Storno AB, a leading manufacturer of two-way radios based in Denmark, and the company's stepped-up participation in cellular radio systems in several European countries as examples.

Bernhard Zurhorst, director general of finance and procurement at the Bundespost, says his agency is now "particularly eager" to attract numerous small- and medium-sized electronics companies "which have not yet crossed the Atlantic." Zurhorst and other top-level German officials noted during a recent visit to the United States that the telecommunications market in their country will grow at a 7% annual rate over the next few years.

"We intend to open our entire terminal supply market with one important exception — the telephone network infrastructure," Zurhorst says. These moves will open up sales for the "auslanders" in a wide range of new fields including satellite transmission, radio paging, modems and related software.

German telecom purchases

Deutsche Bundespost telecommunications equipment purchases ($ billions)



Source: Deutsche Bundespost

Germany's telecom authority now has the green light to buy more from overseas

The major exception still off-limits to outsiders is the telephone system itself. Foreign firms, as well as some European politicians, charge that wide open competition in German telecommunications would eventually allow the giant U.S. and Japanese firms to dominate many EEC markets. Nevertheless, Zurhorst indicates that even within this arena, there are legislative initiatives underway which would extend a "competitive environment" to satellites.

The liberalized satellite market will include point-to-multipoint services with low data transmission rates (for example, distributing information to banks, newspapers and insurance companies), and communication service tying together "widely scattered pieces" with relatively low volumes (for example, point-of-sale transmission for department store chains).

In terms of the telecommunications product market, the terminal supply market has been gradually liberalized in recent years.

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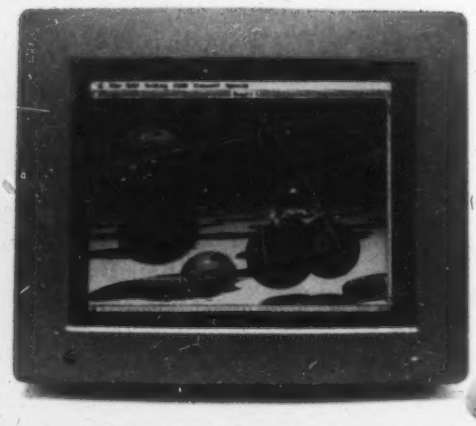

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How to cope with the next recession

The electronics industry may be enjoying a recovery now, but many economists fear a downturn in '89. This is the time for those contingency plans

BY BRUCE C.P. RAYNER

Imagine this. It is October 1989. GNP growth for the third quarter is reported by the Department of Commerce at a negative 0.5%, triggering fears that a recession is in the making. Despite attempts by the Federal Reserve and foreign central banks to intervene, the dollar starts to freefall. Japanese investors pull out of the U.S. bond market, sending prices into a tailspin and interest rates skyward. In sympathy, stock markets around the world begin to slide. The Dow Jones Industrial Average collapses.

By year's end, the electronics industry is feeling the crunch. Bankruptcies are up and capacity utilization is way down. Computer, peripheral, telecommunications and component manufacturers are all reporting slowdowns in orders and shipments, both domestically and internationally. Forecasts for 1990 look even more bleak.

Is this scenario — a severe recession — impossible? No. Is it unlikely? From the vantage point of mid-1988, many noted economists like Lester Thurow, dean of the Massachusetts Institute of Technology School of Management, say that yes, a recession is unlikely (see accompanying story). But while they play down the probability of a serious economic calamity, many also express a deep concern about America's long-term economic health.

Electronics executives should be concerned as well. With the worldwide electronics industry poised to break the $500 billion revenue barrier this year, the industry will become increasingly susceptible to economic cycles. By paying closer attention to economic variables rather than just industry-specific factors, maturing electronics companies will be better equipped to react to the marketplace and track the more moderate long-term growth paths through all phases of the business cycle. "The important thing for us to recognize is that the days of unbroken growth records are over," comments William Conlin, president of CalComp Inc., a $400 million-plus Lockheed Corp. subsidiary that makes computer graphics products.

At the top of the list of economic concerns is the budget deficit. It *has* to be dealt with by the next administration, be it Republican or Democrat, or else the economy will face a dangerous deterioration in future standards of living, economists warn. Fiscal policy tools of both spending cuts and tax increases are suggested. Currently, projections for fiscal year 1988's deficit are close to the $150.4 billion figure for fiscal 1987.

"If you are going to do anything, the time to do it is January or February 1989, and blame President Reagan," suggests Thurow, referring to an implementation of fiscal policy to correct the budget deficit. "If you don't change it in 1989, you are not

Noted economist Lester Thurow—who some say

could be senior economic advisor to the next president—has few doubts about the likelihood of recession.

going to change it in 1990," he adds.

Other economic woes include the rising tide of foreign, corporate, bank and personal debt that could prove disastrous if a recession materializes. For instance, the U.S. interest payment to foreigners is expected to nearly double, from $17 billion in 1981 to $30 billion by 1990, estimates Data Resources Inc. (DRI), an economic forecasting firm. The slow improvements in the trade deficit and the weakening U.S. dollar also contribute to the debt burden. Some economists believe that if the world capital markets were to lose faith in the dollar, there would be little that central banks could do to prop it up.

Economists and industry watchers agree that now is not the time for business leaders to be complacent about the economy, particularly electronics executives. Although the electronics industry appears to be enjoying a healthy recovery, plans should be in place now to minimize the effects of an economic downturn in 1989. Whether the United States will suffer a depression, as maverick economist Ravi Batra predicts, or whether it will continue its mediocre growth, is less important than how well companies are positioned in this time of mounting uncertainty. "It is not too early to start doing your contingency planning and risk analysis and to anticipate which sectors are going to be weaker," advises Edward Henderson, market researcher and president of Los Altos, California-based Henderson Ventures.

Most economists, both corporate and academic, are convinced that the United States will enjoy reasonable economic performance for the remainder of 1988. The Republican party and America's trading partners all want to avoid a recession this year to ensure the election of Vice President George Bush as the next president. The view from overseas is that the Republicans are less protectionist than the Democrats, so foreign governments will be more willing to keep

the U.S. economy afloat until at least after the election. Similarly, the Federal Reserve is willing to play along with the White House so as to give the next president a fiscal policy option in 1989.

Pretty healthy in 1988

The majority of economic forecasts for GNP growth in 1988 range between 2.0% to 3.0%, with both inflation and unemployment kept under control. "For the next six to 12 months, the outlook looks pretty healthy for all businesses that are related to the industrial sector," comments Allen Sinai, chief economist at the Boston Co. Sinai points to a strong amount of spending on information-related equipment and telecommunications both domestically and internationally as evidence of what he labels a boom in electronics.

DRI predicts 2.3% GNP growth for 1988, down from a 1987 growth rate of 2.9%. The real economy rebounded from the October stock market crash of last year and is showing signs of good health. "I think we overestimated the impact of the stock market on the economy," admits David Wyss, chief financial economist at DRI. "We hadn't taken into consideration that 80% of the population doesn't own any stock and only 5% owns a significant amount," he says.

Most executives and economists in the electronics industry share Wyss' view on the nonetfect of the stock market crash. "My feeling is we have weathered the crisis of last October and I now feel we will have good stable growth and a healthy electronics industry this year," says John Mitchell, vice chairman and officer of the board at Motorola Inc. Mitchell is also a director and regional vice chairman of the National Association of Manufacturers and the chairman of the Electronic Industries Association.

James Whittaker, chief economist at Digital Equipment Corp., holds a slightly different opinion. "One thing the stock market crash did at Digital was to make people think a little bit more about the alternatives for the future. Not only did a recession become possible, but a severe recession became possible," he says. Still, Whittaker expects hardware sales growth for the computer industry to range between 10% and 12% for the year, the strongest performance for the past three years. He also expects a mild recession in late 1989 because of "serious economic imbalances."

Most forecasts for GNP growth in 1988 range between 2% and 3%, with inflation and unemployment both under control

DRI's Wyss also believes that 1988 will be good for electronics and pegs the industry to grow at a 10% rate for the year. DRI's capital spending survey points to an 8.8% increase in 1988 over 1987 for plant and equipment spending, close to the Commerce Department's figure of 8%. Exports will strengthen during the year and the dollar will drop to about 115 yen by the election, Wyss predicts. He does not expect a recession in 1988, but there is a possibility in late 1989 or early 1990: "That is the next danger point in the economy," he warns.

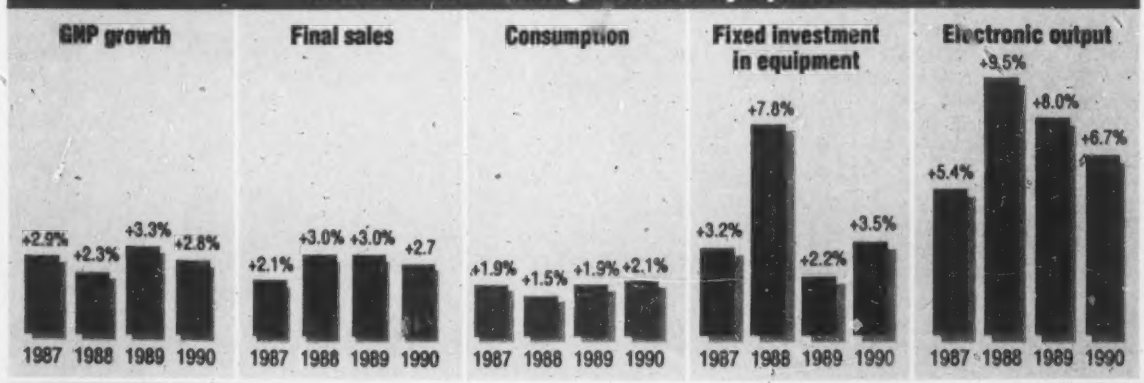
Bullishness prevails

Alan Reynolds, chief economist at Morristown, New Jersey-based Polyconomics Inc. and a staunch supply-sider, is also bullish on the economic outlook. "There is nothing fundamentally wrong with the economy," he says. "It continues to show good growth in production, employment and income, and as for the inflation picture, there is not much evidence that it will get worse."

Reynolds puts the threat of U.S. protectionism at the top of his list of concerns for the future of the U.S. economy. "It seems the trade deficit is less important than what you intend to do about it," he says. Any legislation designed to limit foreign buying patterns would be counterproductive to U.S. industry, particularly at a time when exports are leading U.S. growth, he adds.

At the other end of the forecasting spectrum is Ravi Batra, professor of economics at Southern Methodist University and author of the best-selling book, *The Great Depression of 1990*. Even though he is forecasting a devastating six-year depression, Ba-

Growth rates — Taking the economy's pulse



Sources: Data Resources Inc. and Henderson Ventures

tra expects 1988 and 1989 to be relatively stable (see accompanying article). Where Batra and Reynolds diverge is in their reading of the long-term health of the economy.

Batra points to a growing uneven distribution of wealth as an indication that the economy is destined for trouble. He combines that with a theory of economic cycles that predicts economic calamity every 60 years. By his reckoning, these two will come together in 1990 to cause a depression far worse than the one in the 1930s.

The word for 1989 from Robert Eggert's Blue Chip Economic Indicators newsletter, a consensus forecast of over 50 economists, is for 2.2% GNP growth in 1989. However, there is an unusually large range between the optimists, at 3.8%, and pessimists, at -1.7%. Eggert himself expects a recession to hit in 1989. However, the prospects for computer and office equipment shipments look bright: Eggert expects shipments to hit $60 billion in 1988, rising to $62 billion by 1989. Still, he recommends caution: "If I were in big business, I'd sure have a plan to pull in my horns real quick if I had to."

Henderson agrees with Eggert's scenario, and has an economic recession pegged for late 1989, extending into 1990: "My scenario calls for the next president to increase taxes in 1989, retroactive to the beginning of 1989." The severity of the recession will depend on what legislation is enacted. "My gut feeling is they are going to bite the bullet with a fairly steep tax increase causing a fairly steep recession that will probably last three to four quarters," he says. As for how well electronics will do, Henderson expects the industry to come through the recession fairly well as a result of its stronger export focus. The one caveat is the health of foreign economies.

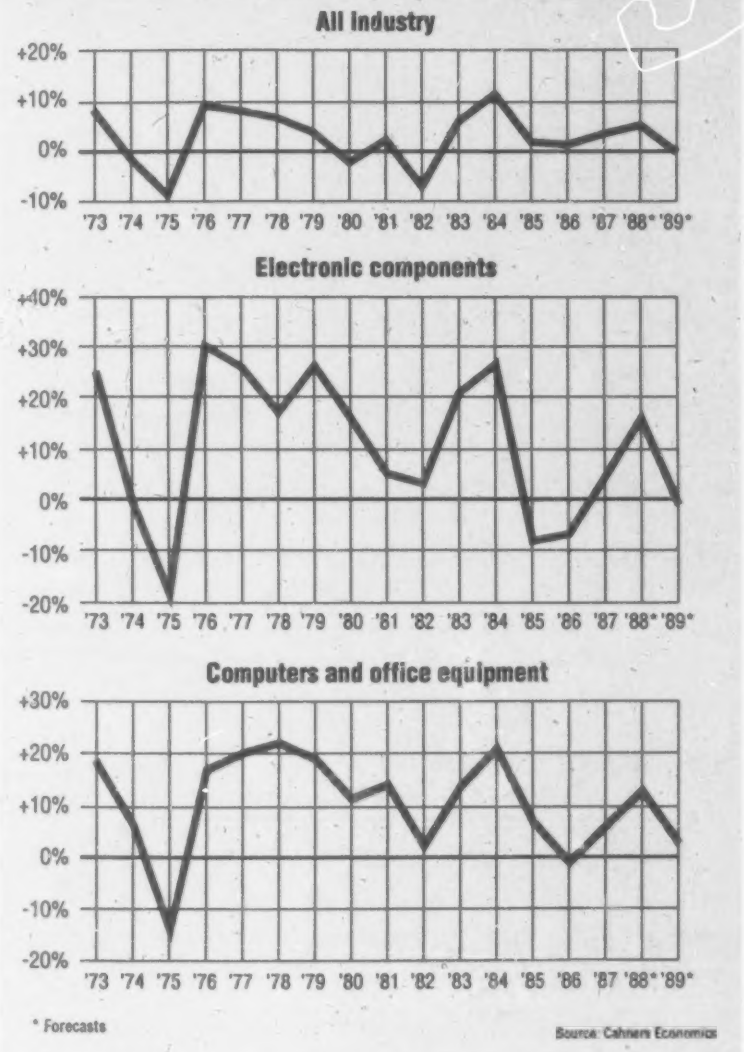
Kenneth McGill, director of technology-intense industry analysis at Wharton Econometrics Forecasting Associates, sees it slightly differently. He expects GNP to hover around 2.9% for 1988 and then slip to 1% GNP growth for the next four or five quarters, before resuming faster growth again in 1990.

McGill is labeling 1989 a "growth recession" year — slow GNP growth coupled with increasing unemployment — brought on by tighter monetary policy leading to higher interest rates and inflation. As far as computer and office equipment is concerned, McGill is forecasting real spending to increase by 7.5% in 1988, dropping to 6.8% in 1989 and 4.5% by 1990.

McGill's scenario calls for monetary tightening in response to increasing inflation and interest rates. Capital equipment spending will be affected, he says, but computer and office equipment investment will come off pretty well. Part of the reason is the low levels of inventories in the electronics industry following the recession of 1985 to 1986. "I think the [illegible] is a conservative posture out there in electronics and that posture will do well for a growth recession

Putting growth in perspective

Industrial production (annual percentage change)



* Forecasts

Source: Cahners Economics

The electronics industry has been volatile, but it looks to be maturing

or a full-fledged recession," McGill says.

McGill points to export growth as the key driver in the economy's health in 1987 and a major contributor to growth over the next two years. He expects exports to slow in 1990 as the dollar begins to gain strength on international markets as a result of rising domestic interest rates. McGill is forecasting the dollar to drop by 8.8% this year in relation to a mix of 40 currencies and again by 3.8% in 1989, before rising in 1990 by a meager 0.3%.

Foreign trade

While the opinion from both executives and economists is that exports are the economy's redemption, progress so far has been painfully slow. While DRI expects the merchandise trade deficit to improve from $171 billion in 1987 to around $141 billion in 1988 and $113 billion by 1990, the improvements to date have not been across the board.

Price-sensitive products, mainly primary products, posted strong export growth in 1987 and in some categories showed surpluses in the current account balance, according to DRI. But in capital goods — including electronics — imports continued to outpace exports, dropping from a surplus of $44.9 billion in 1981 to $3.8 billion last year. Imports of office machinery and data-processing equipment rose last year by 25.8%, outstripping exports and sending the sector into deficit for the first time, DRI reports.

In aggregate, the electronics trade deficit hit $12.7 billion last year, down from a surplus of $7.4 billion in 1980. The American Electronics Association reports that between 1986 and 1987, the balance of trade in electronics between the United States and its 25 top trading partners barely changed at all. While imports rose from $50.6 billion in 1986 to $57.4 billion in 1987, exports increased from $34.0 billion to $40.9 billion.

"If you are going to change fiscal policy, the time to do it is January 1989, and then blame Reagan"
Lester Thurow, MIT

Trade pressure is fiercest in the Pacific Rim, where currencies have been pegged to the U.S. dollar and Americans have come to depend on Asian consumer electronics. While some of the Pacific Rim currencies are starting to inch up, the Hong Kong dollar has yet to budge. Even Japan, the top U.S. electronics trading partner, is absorbing costs to keep its electronics trade balance with the United States at a steady $20 billion.

But it is not only the lack of export penetration in capital goods that is keeping the trade balance in the red. The Department of Commerce estimates that between 1983 and 1986, direct foreign investment in the United States has increased steadily and gives every indication that it will continue this upward trend. The main reason is that a weak dollar is making U.S. factories bargains for dollar-rich foreigners. In electronics alone, direct foreign investment rose from 48 transactions in 1985 to 75 in 1986, valued at $1.8 billion. As for the capital markets, it is estimated that for the last few years, foreigners have been pouring between $150 billion and $200 billion into U.S. stocks and bonds.

Most electronics executives will admit that the dollar is helping their exports, but they all insist that the key to success overseas is a quality product. "For the high-tech industry, it is price-performance and the latest technology that sells internationally," says Thomas Vanderslice, president of Apollo Computer Inc. Apollo does about 50% of its business overseas, mostly in Europe.

While DRI expects the capital-goods trade balance to jump back up to $50 billion by 1990, MIT's Thurow is not so sanguine. He points to the ailing machine tool industry as an example of a domestic industry that is in "the process of advanced collapse." Back in 1978, the American machine tool industry was producing 110% of U.S. demand, says Thurow, but by 1988 that has dropped to 50%. "Even if you had a booming demand for machine tools, it is not obvious that American firms would buy machine tools from American companies," he adds.

While high-technology industry is not suffering to the same degree as machine tools, it does show some of the same symptoms, Thurow says. However, as 1988 wears on, the consensus from most economists is that the weak dollar will spur U.S. high-tech exports. □

The electronics trade balance

U.S. electronics imports and exports (current $ billions)

	1986			1987		
	Exports	Imports	Balance	Exports	Imports	Balance
Japan	$3.5	$24.0	-$20.5	$4.4	$24.5	-$20.1
Other Pacific Rim	6.4	14.0	-7.6	8.3	18.3	-10.0
North America	7.1	5.5	1.6	8.9	6.6	2.3
Europe	12.9	5.9	7.0	15.2	6.4	8.8
Rest of world	4.1	1.2	2.9	4.1	1.6	2.5
Total*	$34.0	$50.6	-$16.6	$40.9	$57.4	-$16.5

* Total includes 25 primary trading partners

Source: American Electronics Association

The electronics trade balance is grim, and still has a long way to go

The word from cautious CFOs: Better safe than sorry

CFOs are often among the most realistic forecasters. While few expect severe recession, most are preparing for some downturn. Here's what they predict

BY BRUCE C.P. RAYNER and MARY DONOVAN

Many chief financial officers of electronics companies are expecting modest growth in the coming year, as uncertainty about the post-election economy mounts.

That's the conclusion of a recent poll by ELECTRONIC BUSINESS of chief financial officers, vice presidents for finance and controllers at 99 U.S. electronics companies. Our annual CFO survey was based on a lengthy questionnaire mailed to 700 chief financial officers in the electronics industry. In all, 99 executives completed the survey for an average response rate of 14.1%.

Results of the survey suggest high-tech CFOs are not inclined to economic pessimism for the rest of 1988 or 1989, even though a growing number are taking steps to minimize the adverse effects of a downturn.

According to a recent ELECTRONIC BUSINESS survey, only 22% of the CFOs and vice presidents for finance polled indicated they expect an economic recession in the coming year. Nonetheless, close to 50% said they are currently taking steps to minimize the adverse effects of a possible economic downturn. The moral of the survey: better to be safe than sorry.

But while some companies expect to feel the heat when the economy softens, others, like Microsoft Corp., think they can weather the storm with little effort. "We feel that the market is there to support the growth in the same potential that Microsoft has been known for," comments Francis Gaudette, vice president for finance and CFO for the software giant. "We are not scaling back relative to any economic condition," he adds.

Gaudette claims that software and other relatively low-cost productivity enhancement investments are countercyclical to the health of the economy in general. If the economy were to turn down, companies would invest in personal computers and software before they bought a minicomputer or a mainframe, he says. For that reason, many workstation vendors and personal computer makers also consider themselves pretty well positioned for 1989.

But for the other half of the industry — those companies that have to pay attention to the economy — an ounce of prevention is better than the bitter medicine. The most popular steps being taken to minimize the effects of the recession by those CFOs surveyed are minimizing inventory, increasing cash reserves, trimming labor costs and postponing capital investment, in that order. Unlike in the early 1980s, very few said they were moving production facilities offshore.

Nearly 50% of CFOs are acting to minimize the effects of a possible economic downturn

For Silicon Systems Inc., an Irvine, California-based maker of standard and custom ASICs, the current economic outlook presents a dilemma: the company needs more foundry space to grow, but could run into trouble with the investment if the economy turns sour. "We are trying to add the capacity that we need in the most cost effective way possible," comments William Bendush senior vice president and chief financial officer of the company. "If there were a downturn in the economy, it would not be beneficial to us."

As far as the effects of the stock market crash on company valuations, 43% of those surveyed responded that the effects had been negative. However, a total of 41% believe that stock valuations of all public companies are currently about right. In terms of the impact of the market crash on sales, an overwhelming 70% said there had been no impact. Sales are expected to grow strongly for the remainder of 1988, but will begin to slow in 1989. While 63% of those surveyed expect sales to increase in the third quarter of 1988, only 54% expect an increase by the second quarter of 1989. As for the outlook on Wall Street for the remainder of 1988, most CFOs expect continued uncertainty in the stock market, but no major changes.

Concerning the presidential election in November, most CFOs expect a Republican to take the reins. However, respondents say the election will either have no effect on the electronics industry or that they are still uncertain about the effect. This reflects either a lack of awareness of what candidate George Bush stands for in economic policy, or a lack of commitment by the candidate himself.

As far as other economic vital signs: CFOs expect the dollar to remain stable and possibly weaken by year's end and the trade deficit to improve in the next 12 months. Surprisingly, 54% of those surveyed expect the budget deficit to get bigger over the next two to three years. Both inflation and interest rates are expected to remain stable or perhaps increase over the next six months, and both labor and precious metals will increase in price, they believe. Acquisition activity is also expected to rise over the next year. □

DEMAND

Over the next four quarters, what do you expect demand to be for your company's product?

	3rd qtr. 1988	4th qtr. 1988	1st qtr. 1989	2nd qtr. 1989
Increase	63%	74%	54%	54%
Decrease	16%	2%	8%	8%
Stay the same	20%	23%	33%	29%
Don't know	1%	1%	5%	9%

BUSINESS DIRECTION

In the second half of 1988, which of the following will change at your company and in what direction?

	Stay the same	Increase	Decrease	Don't know
Manufacturing capacity	41%	55%	4%	0%
Capital investment	46%	46%	7%	1%
R&D investment	41%	55%	3%	1%
Inventories	33%	33%	33%	1%

POSSIBLE RECESSION

In the coming year, do you expect a recession for the economy as a whole?

Yes	22%
No	78%

Is your company now taking any steps to minimize the adverse effect of a possible recession?

Yes	48%
No	50%
Don't know	2%

If your company is now taking steps to minimize the adverse effect of a possible recession, what are they?

Minimizing inventory	35%
Increasing cash reserves	28%
Trimming labor costs	27%
Postponing capital investment	20%
Moving production offshore	6%
Postponing raising funds	2%

INTEREST RATES

In the second half of 1988, interest rates will:

Increase	55%
Decrease	9%
Remain about the same	33%
Don't know	3%

STOCK MARKET

The stock market crash of October 19, 1987, has had what effect on your company's sales?

Positive	5%
Negative	19%
No effect	69%
Don't know	7%

The stock market crash of October 19, 1987, has had what effect on your company's valuation?

Positive	2%
Negative	44%
No effect	49%
Don't know	5%

In the second half of 1988, what do you expect to happen on the stock market?

Another crash	1%
Bear market (down)	18%
Bull market (up)	7%
Continued uncertainty but no major changes	74%

CORPORATE VALUATIONS

Do you believe that public valuations are currently:

About right	41%
Too high	24%
Too low	24%
Don't know	11%

TRADE

Will the U.S. trade deficit continue to improve over the next year?

Improve	52%
Worsen	35%
Don't know	13%

How will trade legislation affect you company in 1989?

Positively	19%
Negatively	28%
No effect	33%
Don't know	20%

What impact will tougher trade legislation have on the U.S. economy?

Positive	21%
Negative	43%
No effect	5%
Don't know	31%

DOLLAR VALUE

In the second half of 1988, do you expect the value of the U.S. dollar in relation to major trading partners' currencies to:

Increase	21%
Decrease	32%
Remain about the same	44%
Don't know	3%

INFLATION

In the second half of 1988, inflation will:

Increase	43%
Decrease	2%
Remain about the same	53%
Don't know	2%

TAX REFORM

As a result of the 1988 tax reform bill, what do you expect your company's 1988 tax burden will be, compared with 1987?

Higher	33%
Lower	22%
About the same	32%
Don't know	13%

MERGERS AND ACQUISITIONS

What will happen to the rate of mergers and acquisitions in the electronics industry next year?

Increase	45%
Decrease	8%
Remain about the same	37%
Don't know	10%

RAISING FUNDS

In the second half of 1988, if your company will need to raise funds, from which market do you expect to get the money?

Bank loan	54%
Private placement	36%
Public market	5%
Bond market	3%
Initial public offering	2%

PRECIOUS METAL PRICES

In the second half of 1988, prices for precious metals used in electronics will:

Increase	46%
Decrease	6%
Remain about the same	32%
Don't know	16%

MILITARY ELECTRONICS

How would you characterize the market for military electronics next year?

Excellent	2%
Good	39%
Fair	53%
Poor	6%

LABOR COSTS

In the next year, labor costs will:

Increase	68%
Decrease	3%
Remain about the same	29%
Don't know	0%

BUDGET DEFICIT

What will happen to the U.S. budget deficit in the next two or three years?

Get bigger	54%
Get smaller	21%
Stay the same	19%
Don't know	6%

Semiconductors

Total U.S. semiconductor consumption
($ billions)

	1988	1989	1990
MOS logic	$4.36	$4.78	$4.63
MOS memory	3.20	3.64	3.33
Linear ICs	1.61	1.65	1.54
Bipolar memory	0.25	0.24	0.21
Bipolar logic	1.56	1.44	1.31
Total ICs	**$10.99**	**$11.75**	**$11.03**
Discretes	1.99	2.03	1.96
Total	**$12.98**	**$13.78**	**$12.99**

Sources: In-Stat Inc., Dataquest Inc.

What's ahead

- Memory chip shortage in DRAMs, SRAMs and EEPROMs. Demand will exceed supply throughout 1988.
- 1989 will show reasonable growth, but recession in 1990 will depress total IC unit sales. As chip shortages ease, prices will fall again, forcing down semi dollar volume.
- RISC chips will challenge standard architecture.
- Compound annual growth rate in the Asia-Pacific region will be 24% between 1987-1992, twice the rate of the U.S. and Japan.

Semiconductor production equipment

Worldwide semiconductor production equipment sales
($ millions)

	1988	1989	1990
Microlithography	$1,423	$1,566	$1,668
Diffusion	248	285	329
Ion implantation	334	489	585
Deposition	1,022	1,176	1,321
Etch	796	896	997
Wafer making	76	81	89
Total	**$3,899**	**$4,493**	**$4,989**

Source: VLSI Research Inc.

What's ahead

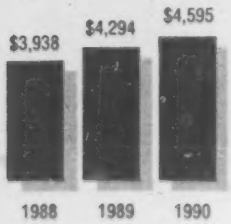
- Overall industry sales will increase 39% in 1988 and 15% in 1989.
- Growth is coming from: the change from a consumer-driven economy to an export-driven one; and from the tight capacity limitations of U.S. semiconductor makers.
- IC equipment makers should be less concerned about a possible downturn than about an excess in ordering.
- Among the segments that will gain most: ion implantation and deposition.

Semiconductor materials and chemicals

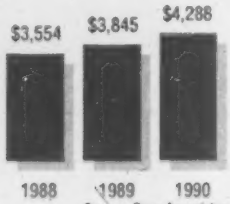
What's ahead

- 1988 will show 12% growth in unit volume of materials and chemicals, and 7% growth in value.
- Japan will continue to be a very strong materials supplier in the U.S. market.
- In the next two or three years, Korean products will emerge in the U.S., claiming up to perhaps 5% of the market.

Worldwide IC fabrication materials consumption
($ millions)



Worldwide IC packaging materials consumption
($ millions)



Source: Rose Associates

Components

What's ahead

- Passive components will show slow growth in contrast to the inflation rate. While sales growth will run in the double digits in most sectors this year, it will slow sharply in 1989.
- Connector revenue growth will slow from 14% for 1988 to under 6% in 1989.
- Capacitor sales will brake next year, with revenue growth of under 4%.

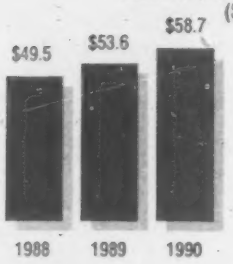
U.S. production of electronic components
($ millions)

	1987	1988	1989
Relays	$580	$681	$698
Switches	632	747	766
Connectors and sockets	3,771	4,318	4,574
Capacitors	2,058	2,392	2,485
Resistors	878	989	995
Printed circuits	4,021	4,753	4,967

Source: ElectroniCast Corp.

Computers

Value of U.S. computer hardware
($ billions)



	1988	1989	1990
Large scale	$9.40	$9.40	$10.20
Medium scale	9.05	9.7	9.85
Small scale	9.7	8.5	9.7
Personal computer	22.58	25.27	28.96
Total	**$49.53**	**$53.57**	**$58.71**

Source: International Data Corp.

What's ahead

- Between 1988 and 1992, the compound average growth rate of U.S. computer sales will be 8% to 9%. New 80386-processor computers will have faster yearly growth at 12% to 13% in 1988 and beyond.
- The Unix market will grow faster than other systems sectors. At present, a third of the market is in mainstream IBM and DEC proprietary systems and a third in Unix and MS/DOS environments.

Computer peripherals — Storage devices

What's ahead

- Write once/read many (WORM) drives are showing up increasingly in applications such as document storage, disk backup and archives.
- Erasable optical disk drives are expected to appear in the market later in 1988, with some shipments in the fourth quarter.
- The flexible disk-drive market continues to suffer from oversupply with price erosion. In rigid-disk drives, overcapacity is expected in the less than 100MB category.
- Tape drive sector is moving to oversupply this year.

U.S. rigid-disk drive and optical storage revenue
($ millions)

	1987	1988	1992
Rigid	$13,057.4	$16,700.7	$28,268.6
Optical	248.0	436.7	$2,995.0

Source: Dataquest Inc.

Worldwide flexible-disk drive shipments
($ millions)

	1988	1989	1990
8-inch drives	$104.9	$47.9	$24.7
5.25-inch drives	1,225.4	1,035.8	828.9
Microfloppy drives	1,048.5	1,241.1	1,388.5
Drives over 5 megabytes	92.0	111.9	164.2
Spiral track drives	10.1	3.6	1.0
Total	**$2,480.9**	**$2,440.3**	**$2,407.3**

Source: Disk/Trend Inc.

Tape drive revenue
($ millions)

	1988	1989	1990
Cassette more than 5MB	$40.3	$50.4	$58.9
Minicartridge more than 5MB	202.3	264.0	313.7
Cartridge 20MB-80MB	268.8	231.3	182.8
More than 80MB	78.1	134.1	194.6
Total	**$589.6**	**$679.8**	**$749.8**

Source: Freeman Associates

Computer peripherals — Display terminals

What's ahead

- Fierce economic battles are being waged for market leadership, and margins have shrunk to the point where few companies show reasonable profits.
- Distribution channels for low-end terminals are moving to mail order/phone order. Major avenue for company growth is in mergers and acquisitions.

U.S. display terminal revenue
($ millions)

	1987	1988	1992
Minicomputer	$934.7	$956.9	$461.0
Non-IBM	118.0	93.2	20.0
IBM 3270	1,212.4	1,222.5	765.0
Non-host	684.0	648.0	464.0
Processing	40.6	82.7	1,005.3

Source: Dataquest Inc.

Computer peripherals — Printers

What's ahead

- U.S. manufacturers will be seen moving production back on shore. Japanese vendors are also setting up manufacturing plants in the U.S. Low labor content in printer manufacturing makes low rates overseas less significant in production.
- Successful implementation of factory automation systems is critical to the ability of vendors to strengthen profit margins.
- Laser printer performance should get a big boost during 1988 with new chip sets and controllers bringing speed more in line with end-user expectations.

U.S. printer revenue
($ millions)

	1987	1988	1992
Serial	$3,213.7	$3,415.3	$3,375.9
Line	1,240.4	1,266.7	1,113.3
Page	2,590.7	3,596.9	5,502.4

Source: Dataquest Inc.

CAD/CAM/CAE

Worldwide revenue of U.S. CAD/CAM/CAE systems vendors
($ billions)

Sources: Daratech Inc., Dataquest Inc.

What's ahead

- More consolidation will be seen in 1988 and beyond.
- Growth rates are slowing, markets are becoming increasingly specialized. Falling workstation prices and oversupply for vendors are the major force behind this trend.
- Overseas markets, especially Europe and Japan, are growing much faster than the U.S.
- Major problem facing most CAD/CAM/CAE vendors is the decline in workstation prices caused by shift toward low-cost workstations and personal computers. Prices have fallen an average of 25% per year since 1984. In 1987, prices fell 20%.

Test & measurement

What's ahead

- 1988 should see double-digit growth at 12%. The overall growth rate will slow down in 1989. The industry should pick up slightly in 1990.
- The international market will have higher growth rates than the U.S. market.
- The devaluation of the dollar is giving market share to U.S. manufacturers in both domestic and international markets. Exports to Japan have been increasing since 1987, a trend that should continue through 1989.
- The highest potential growth in applications will be in the aerospace and defense industry.
- More integration in instrument functionality will be seen during the next five years.

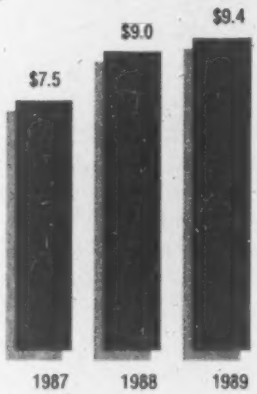
Test instrument sales
($ millions)

	1987	1992
ATE	$1,689	$12,510
Oscilloscopes	1,023	1,675
Logic analyzers	291	650
Microprocessor development systems	477	950
Other instruments	3,549	5,735
Total	**$7,038**	**$12,510**

Source: Prime Data Inc.

Distribution

Sales by U.S. distributors
($ billions)



Source: National Electronic Distributors Association

What's ahead

- Firming prices and stronger exports by customers will produce a 21% improvement in U.S. distributors' sales in 1988.
- Quality is now a major issue for distributors, forcing reevaluation of suppliers and possible fresh rounds of vendor reductions.
- Despite one full point increase in distributors' inventory turn rate over the past year, there is still a need to find ways to fill small orders more efficiently.
- Sales of computer-systems products continuing to grow at larger distributors.

Communications

What's ahead

- Technology is no longer the driving force; market factors predominate.
- Larger companies are becoming the focus of innovation.
- Continued slowness in user buying decisions despite price erosion and an infusion of value-added capabilities.
- Increased emphasis on customer support. Upgradability will be integral to product design and marketing strategy.
- Increased internationalization of telecom markets.
- Connectivity and network management are the keys to account control. Compliance with standards becoming critical.

U.S. telecommunications market revenue
($ billions)

	1987	1988	1992
Public services	$133.3	$142.8	$187.1
Business communications equipment	11.0	11.7	14.3
Public services communication equipment	6.9	7.3	8.6
Data communications equipment	4.9	5.9	9.5

Source: Dataquest Inc.

Comments on industry direction were based on interviews with independent analysts

Instrument makers' comeback to CASE: Beat it or join it

Computer-aided software engineering is shaking up makers of development-systems instruments. Here's how two of them are reacting

BY DAVID CARD

The latest "buzz acronym," CASE — for computer-aided software engineering — is stirring up the instruments market. That's because any system with an embedded microprocessor requires that its software be debugged and tuned up by engineers who have to plug into that system through instruments such as emulators, logic analyzers and microprocessor development systems. Players in this development-systems business, which will amount to $560 million worldwide this year, have to figure out just where they fit in CASE, or risk becoming also-rans.

However, the CASE business is tough to pin down. Most industry watchers define it this way: besides the instrumentation hardware, CASE includes front-end structured design and analysis software, compilers, assemblers and high-level languages, not to mention the computers they all run on. According to Andrew Rappaport, president of Boston market researcher The Technology Research Group Inc., the U.S. market for embedded-microprocessor CASE software is worth only $40 million this year, but could soar to $550 million by 1994.

To get a piece of that elusive market, instrument leader Hewlett-Packard Co., with $8.1 billion in computer and instruments sales, can take its development systems, plug them into its engineering workstations and resell front-end software, calling the conglomeration "CASE."

But smaller instrument companies, such as Applied Microsystems Corp. and Northwest Instrument Systems Inc., don't have the resources to go after CASE head-on. The two private, Pacific Northwest companies, both founded in 1981 and both expecting $20 million in sales this year, have decidedly different approaches: oversimplified, Applied is out to beat CASE, while Northwest means to join it. Their strategies are illustrative of the directions that managers of small companies must take when a significant new technology rolls into town.

Northwest's direction is dramatic: the firm is so keen on CASE that it changed its name. The former maker of PC plug-in instruments calls itself MicroCASE Inc. as of last month. "We want to be *the* software system integrator," says president Lawrence Sutter. "It's kind of analogous to what Mentor is doing on the hardware design side." Mentor Graphics Corp. is the leader of the computer-aided engineering market, with over $220 million in sales last year.

Being the Mentor of software design will be a big job for Sutter's Beaverton, Ore., company. For one thing, Mentor just bought out Tektronix Inc.'s CASE division. And Hewlett-Packard resells the same front-end CASE software from Cadre Technologies Inc. that MicroCASE does. "HP is focused on using the tools on their 9000 workstation," says MicroCASE vice president Michael Maerz. "We're not interested in the 9000 — we'll take [workstations from] Sun, Apollo, VAXs [from Digital Equipment Corp.] and PCs and leave the 9000 to HP." Plus, MicroCASE and Cadre have a joint development pact that should produce new products this summer.

Ironically, MicroCASE is moving away from plug-in instruments, a market it helped pioneer, just as that market is starting to take off. Galen Wampler, president of San Jose market research firm Prime Data Inc., forecasts that computer-dependent instruments will grow at a 24%

Adaptive strategies for the evolving CASE instruments market

Chuck D'Ambrosia
president
Applied Microsystems

Focus on supplying "if not the Cadillac, certainly the BMW" of emulators by:

- Concentrating on workstations
- Honing internal design and manufacturing
- Shifting to selling direct and doing plenty of rental business
- Developing own software as well as dealing with Intermetrics and Microtec Research
- Launching subsidiary in Japan and overhauling European distributors

Source: Applied Microsystems

Larry Sutter
president
MicroCASE

Shift from PC plug-in instruments to software development systems by:

- Acquiring Atron for software and emulators
- Joint marketing Microtek International emulators
- Cutting software deals with Microtec Research and Cadre Technologies
- Changing company name from Northwest Instrument Systems to MicroCASE

Source: MicroCASE

rate, from $437 million last year to $1.3 billion in 1992. Toward the turn of the century, these instruments could account for 40% of the instrument business, he says, way up from 2.5% last year. MicroCASE still sells parts of its catalog into that market.

Northwest originally made oscilloscopes and logic analyzers that plugged into PCs, but that business never got them above the $15 million mark, Wampler says. The analyst believes that Northwest has been under some pressure to succeed from its venture capital backers, which, he says, have pumped some $15 million into the company. "Those guys are used to Tandem," Wampler says, "they expect a $50 million to $100 million company." But Wampler points out that MicroCASE has been able to grow faster than most instrument start-ups.

MicroCASE's Software Analysis Workstation is a cluster of instruments and software that runs on a PC to give a "CAT scan of embedded systems," as Maerz puts it. MicroCASE resells software compilers and emulators from third parties to make up a complete development system. Its system is good enough that Intel Corp., the former development systems leader, now resells some MicroCASE products.

Others have praise for MicroCASE, including competitor James Ready, vice president of Ready Systems Corp. Ready concedes that MicroCASE has a "good box, but it comes way late in the design process," he comments. Ready Systems is best known for its real-time operating system, VRTX, but is launching its own set of design tools under new president Aryeh Finegold, a founder of CAE pioneer Daisy Systems Corp.

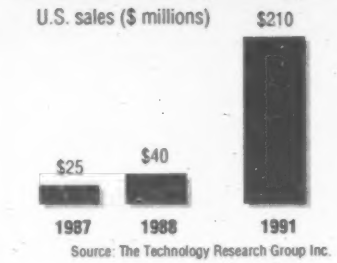
Beating the CASE crowd

Tackling CASE technology from the other direction is Applied Microsystems, which is intent on coexisting with the CASE crowd, rather than being coopted by it. "I'm relatively conservative; I like to take little steps," says president Charles "Chuck" D'Ambrosia. He prefers that his Redmond, Wash., company fit into the "CASE confusion," rather than become a CASE systems integrator. Too much diversification can be dangerous, D'Ambrosia says; "Most small companies don't have the capital to see it through." Applied is profitable and largely self-financed, with under $3 million in venture capital.

Development-system instruments sales

Sales of instruments that fit into CASE are growing steadily...

CASE software for embedded systems sales



...but CASE software is coming on strong

Applied sells emulators, and D'Ambrosia's objective is that they be the best emulators. "I'm not trying to out-Japanese the Japanese, which is to sell on price. All of our products are premium products," he says. "If the industry demands this level of support, they damned well better be able to pay for it." To make Applied's pricey emulators accessible to smaller companies, Applied sells to instrument rental companies. They account for roughly one-fourth of its business.

The Teledyne Controls division of Teledyne Inc., for one, is willing to pay for the support. "It's worth the money for, if nothing else, the product support," says Teledyne Controls vice president James Winchester. He uses Applied emulators to develop the software for on-board and ground support systems for aircraft. Winchester likes Applied's flexibility in the face of CASE. He picked his emulator based on what software it supported.

Another Applied customer, Paul Person, principal software engineer for Satellite Technology Management Inc., has a slightly different take on software support. A third-party debugger he bought from Applied three years ago "wasn't very closely married to the emulator, and I was very fond of the emulator." Person, whose company makes satellite-network systems for banks and airline reservations, says things have come around since then. In fact, as he goes from Motorola Inc. 68010 processors to 68020s, he's looking only at Applied for upgraded emulators.

Market researcher Wampler says Applied is doing all the right things in emulators — concentrating on 32-bit processors and making systems geared for workstations. "They're also emphasizing the software area," he says. "Each year software becomes a larger percentage of their business and that's the way it should be."

Applied makes sure the hardware part of its emulators holds up as well. Applied is a heavy user of CAE and CAD — its workstation-to-engineer ratio is closer to 1-to-1 than 1-to-2, a heavy investment for a small company. Applied also uses manufacturing technologies like a materials-requirement planning system and just-in-time delivery of parts. Vice president Richard Jensen says that to ensure quality the company is installing its own surface-mount assembly line.

Looking abroad

To broaden its perspectives, Applied is looking abroad. "One of our major objectives this year is to go with a vengeance into the international market," D'Ambrosia says. Currently, 7% of Applied's sales are foreign. D'Ambrosia, a former Data I/O Corp. executive, says: "At Data I/O we did 40% of our business internationally. There's no reason we can't do that here." To that end, Applied last month launched a Japanese subsidiary and reshuffled its European distributors last year. □

Putting Japanese venture capital to work in America

Need financing and can't find it in the U.S.? Try Japan. At least one venture capitalist there is interested in funding U.S. electronics start-ups

BY ALDEN M. HAYASHI

U.S. start-ups in need of financing should not overlook Japan as a source of equity. Indeed, the cash-rich Japanese, backed up by their brawny yen, are actively looking for financial opportunities overseas, asserts Mitsuo Goto, executive managing director of the Japan Associated Finance Co. (JAFCO), a Tokyo-based venture capital company.

So far, a few U.S. electronics firms — all in California — have taken advantage of JAFCO's fund: Milpitas-based Attain Inc., a manufacturer of chip test equipment; Micronix, of Los Gatos, and Novellus Systems Inc., headquartered in San Jose, both semiconductor production equipment vendors; and Syquest Technology, a hard disk drive manufacturer, based in Fremont. The average investment was $1 million per company, a pittance considering JAFCO's overall size. The company currently controls a $700 million fund, Japan's largest venture capital account.

Goto strongly asserts that JAFCO will step up its U.S. activities, despite the negative effects of the high-valued yen. Goto is undaunted by the fact that an investment made two years ago at $1 = ¥250 would lose 48% of its value, all other things being equal, if redeemed at the current $1 = ¥129 rate.

"Even with the severe change in exchange rates, I am confident that we can prosper in the United States," says Goto. "The cradle of high tech is in America, so we would like to invest more here." Last November, JAFCO opened a New York City office in order to expand its U.S. subsidiary: JAFCO America Ventures Inc. of Menlo Park, Calif., established in 1984.

When screening investee candidates, Goto says the first thing he looks at is the quality of the start-up's management. In addition, because JAFCO does not often have the resources to conduct a thorough investigation, Goto often bases his judgment on the caliber of the start-up's other investors. The prospective firm's actual product, says Goto, is of secondary importance. "If the company's management is good, we can invest in any industry," he asserts.

"In simple terms, our aim is to direct a flow of capital from the Tokyo capital market to the world," says JAFCO's Mitsuo Goto

Jon Colletti

Indeed, not all of JAFCO's investments have been in the high-technology field. Of the company's total holdings in shares and bonds last September, companies in the finance and services industries accounted for 23% of the total; retail and restaurant, 6%; construction and real estate, 6%; and automotive, 3%. Electronics and computer firms made up for less than a third.

Apparently, Goto knows what he's doing. Roughly 40% of the company's investees went public within four years after JAFCO's initial investment. Such success has grabbed the attention of several U.S. law firms and the Big Eight accounting companies, many of which now want to coinvest with JAFCO, according to Goto. Failures, however, are not unknown. Of the 456 companies that JAFCO has financed to date, 27 have gone bankrupt.

Regarding the company's U.S. investments, Goto says, "Unfortunately, we've not been extremely successful yet." He declines to give more details but he does add, "We are very happy regarding Novellus. They're a good company."

Novellus' strengths notwithstanding, Wall Street's Oct. 19 crash has had a depressing effect on many private companies' initial public offerings. Still, Goto remains adamantly loyal to the private sector. "I have heard that many U.S. venture capitalists made investments in NASDAQ companies because their stock prices became so low.

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But JAFCO has never made an investment in a public company and we will never do that."

A well-connected firm

For U.S. electronics start-ups, linking up with a foreign venture capital firm like JAFCO has its advantages. For one thing, JAFCO can help a U.S. company enter the Japanese market. "We have connections with all kinds of industries in Japan," says Goto. Indeed, due to JAFCO's origins — the company was founded 15 years ago by Nippon Life Insurance Co., Japan's largest life insurance company; The Nomura Securities Company Ltd., the largest securities house in the world; and The Sanwa Bank Ltd., one of Japan's largest banks — Goto boasts ties with many of the major electronics conglomerates in Japan.

Another advantage of using financing from Japan is that Japanese venture capitalists, or Goto at least, appear to be less demanding. While U.S. venture capitalists sometimes expect as much as a 60% return on investment using a compound annual growth rate, JAFCO is satisfied with 25%, according to Goto. However, he cautions that the 25% figure is based on his experiences in Japan. In general, U.S. ventures are riskier, he says. "We do not have enough experience in the U.S. to know what type of figure to expect."

But foreign capital does have its disadvantages. In addition to Internal Revenue Service and Securities and Exchange Commission considerations, U.S. companies contemplating foreign financing should be careful if they do any government contracting, warns Donna M. Sherry, head of the high-technology department of law firm Gaston & Snow of Boston.

Furthermore, Barney Ussher, vice president of MIP Equity Advisors Inc. in Boston, asserts, "People overseas are not as tuned into the market here." The geographical gap can pose other problems. "I cannot get as quick approval for more funds as when I was at Paine Webber," says Daniel Alexander, senior vice president of BMW Technologies Inc., the U.S. venture investment arm of auto giant BMW AG of West Germany.

The geographical distance, however, does have its benefits, particularly if a start-up's financing comes from JAFCO. Goto expresses disdain at the infighting that often occurs in the United States between a start-up's founders and its venture capitalists. "Unless we are asked for help first," he asserts, "we never interfere with a company's management."

As a sign of sincerity and trust, Goto says that when he invests in a start-up, he does not ask for a board of directors seat. Instead, Goto says he relies on coinvestors to protect JAFCO's interests. "That is why I always say that the start-up's coinvestors are very important when we make the original decision to invest."

To date, JAFCO has been the main source of Japanese venture capital for U.S. start-ups, claims Goto. He estimates that of all the Japanese venture capital invested in the United States thus far, JAFCO accounted for roughly 80%. Still, Goto predicts, "Other Japanese venture capitalists will follow, depending on how well we do." □

Japan's venture capital funds

	Size of fund* ($ millions)
Japan Associated Finance	$705
Nippon Investment & Finance	224
Yamaichi Uni Ven	174
Techno-Venture	73
Nikko Venture Capital	70
Japan ASEAN Investment	54
New Japan Finance	43
Kokusai Finance	37
Schroder PTV Partners	35
Sanyo Finance	31
Orient Capital	26
TKC Management Consulting	22
The Diamond Capital Co.	18
Hyogin Capital	18
Daiwa Business Investment	16
Nippon Enterprise Development	15
Kanagyo Kakumaru Investment	13
Cosmo Finance	12
Wako Finance	8
Okasan Finance	8
Toyo Finance	5
Jameel S.I. Corp.	5
Total	**$1,514**

* As of January 1988
Conversion rate: ¥130 = $1
Source: Japan Associated Finance Co. Ltd.

Array processors: Boards and boxes battle it out

It's still a slow-growing niche, but board-level products have added some bite to the $225 million array processor market

BY STEVE GROSS

The array processor market has settled into its stagnant status as a niche that won't go away, but doesn't seem to grow much, either. Total industry sales are around $225 million, and no one is predicting big gains.

Fewer than a dozen players are in the market, and they are divided between the traditional attached processor makers at the high end and some newer circuit board manufacturers at the low end. Prices range from as little as $2,000 for a board-level array processor to a maximum of $265,000 for an attached array processor, and performance ranges from about 8 megaflops to 100 megaflops (million floating point operations per second). Most are 32-bit machines because applications such as sonar signal processing require the speed but not the additional scientific accuracy that 64-bit architecture provides.

While a slowly growing market might seem unattractive, the companies that are in it believe they've found a niche where they can make money, even in the worst of times. However, analyst Jeffry Canin of Hambrecht & Quist Inc., in San Francisco, says he believes array processors are largely a break-even industry these days.

But things aren't as bad as they might appear from the $29.2 million loss recorded last year by Floating Point Systems Inc., the Beaverton, Ore., firm that commercialized the array processor in 1975 and leads the market in installations with 8,000 out of an estimated industry total of nearly 20,000. In May, the company laid off 160 employees, or 20% of its workforce. Canin says the array processor portion of Floating Point's business, which also includes standalone supercomputers, wasn't the main cause of the loss.

Jim Christiansen, array processor product manager at Floating Point, allows that "the array processor business is doing better than the company as a whole . . . Our profit margins are considerably better." Floating Point's products range in price from $45,000 to $100,000 and offer performance ranging from 8 megaflops to 72 megaflops, he says.

"At the high end of the market there don't seem to be any emerging new players. All of the emerging companies are starting at the low end, trying to add boards on to personal computers," according to Christiansen.

He continues: "Obviously [the board makers] will take some business away from us. But there are still a lot of higher end applications that need more power than just a single board can offer . . . .We focus our attention at the high end, where people need multiple computational engines rather than single boards."

According to Canin, after Floating Point, the array processor leaders, based on revenue, are Star Technologies Inc. of Sterling, Va.; CSP Inc. of Burlington, Mass.; Numerix Corp. of Newton, Mass.; and Analogic of Peabody, Mass. Other competitors include Aptec Computer Systems Inc. of Portland, Ore.; Mercury Computer Systems Inc. of Lowell, Mass.; and Sky Computers Inc., also in Lowell.

"The current list of players will probably survive," Canin says. "I don't think you'll see anything like a bloodbath. If the market doesn't look fast-growing it keeps too many competitors from entering it." But, adds

Sharon Farmer

Star Technologies' Robert Collias says chips and boards are rapidly taking over the low end of the array processor market

Canin: "Eventually there [may be a lot of] living dead companies, and there may be some mergers down the road."

Canin estimates that total sales of system and board-level products last year stood at $225 million, and that they will reach about $380 million in 1991, an annual growth of 14% to 15%.

The chief applications for array processors are signal processing, such as radar and sonar analysis for the government; image processing, such as enhancing satellite photos; real-time simulations; processing of oil industry seismic data; and processing medical images such as CAT scans. But, the oil industry market for array processors has declined sharply with the drop in oil prices, and Star Technologies seems to have cornered a large chunk of the medical business with its supply agreement with GE.

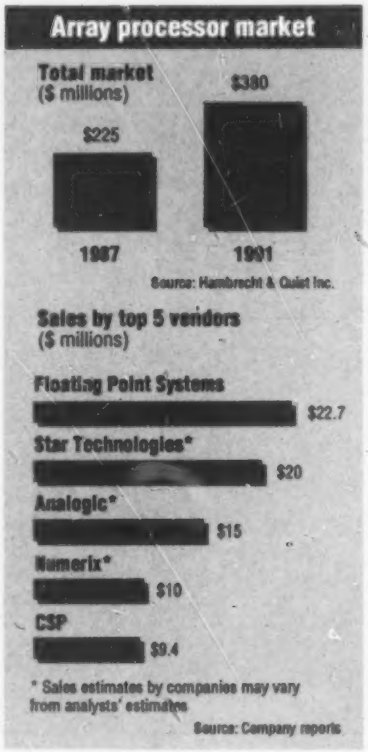
Broadening into boards

Dave Birkner, senior vice president and general manager of the computer design and applications division of Analogic, says it's important to pick the right market. Analogic targets the medical, materials testing and government segments.

"For well-defined imaging and signal-processing applications . . . the array processor is very cost effective. Our business in array processors is certainly growing at the 20% rate," he says. "But for general scientific applications, the array processor is becoming less attractive" because of tough competition from general-purpose minisupercomputers. If he were with a company that sold only attached processors, adds Birkner, "I'd be real worried right now."

Birkner says Analogic, which had array processor sales of about $15 million last year, is focusing on board-level products in its original equipment manufacturer (OEM) business, which accounts for 90% of the firm's revenue. Its boards are designed for computers from Digital Equipment Corp., Hewlett-Packard Co., Perkin Elmer Corp. and others.

"For OEM applications, the board-level products effectively have squeezed out the boxes," he says. "We sell box-level products, but our new products are always available, especially to OEMs, as board-level products." A single 8-inch by 10-inch board for DEC's MicroVAX, for instance, sells for $10,000 and offers 20 megaflops of speed.



However, Birkner predicts that the attached processor business won't disappear because some customers need the units for use with computers that were designed 10 years ago. Redesigning those computers to use array processor boards isn't economical for customers, he contends.

Robert Collins, director of corporate development at Star Technologies, says more than half of his firm's revenue, or about $20 million, came from attached array processors sold for medical imaging, mainly to GE. Signal processing and satellite imaging for the military is a second strong market, and the oil company business seems to be improving, he says.

All things considered, the business is holding up better than he expected, Collins maintains. "Certainly, Floating Point has fallen on some real hard times, and I think a couple of other companies are not real robust . . . But nobody's disappeared lately. I'm a little surprised."

Star's $90,000 ST50, a 50 megaflops machine, and its $265,000 ST100, a 100 megaflops device, are aimed at the very high end of the array processor market. Such machines can compete with general-purpose minisupercomputers, such as machines from Convex Computer Corp., he says, because the array processors can achieve higher sustained speeds for specific applications.

Boards versus boxes

But boards are making impressive headway. "The truth is that chips and boards are rapidly overwhelming the low end of the array processor market. It's very easy to put a board together . . . and get 12 megaflops for less than $15,000 that people can use in an IBM PC-AT," Collins says. "We're not unaware that guys eventually will be able to build more powerful machines using chips."

Still, attached processors offer advantages. "It's still very difficult in the board-level arena to get the software development tools that one needs," says Larry Zagorsky, marketing director for attached processor maker Numerix.

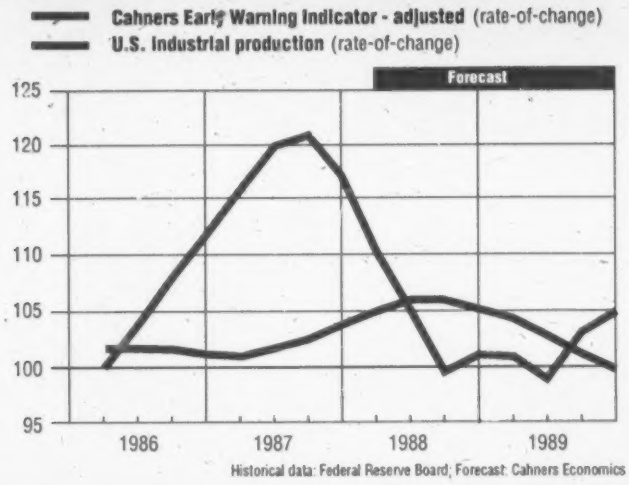
Ray Sansouci, director for marketing at Sky Computers, believes board manufacturers will prosper because they can help standard computer and workstation manufacturers like DEC and Sun Microsystems Inc. compete with application-specific hardware.

"The standard platform companies say they can add in the array processor with a board so they can compete against custom systems," Sansouci points out. "If you leverage a standard product with add-on products like array processor boards, it will do something like a customized workstation does . . . If that's the way it works, Sky will have business for awhile, because the workstation people need boards to go after niches others have already gone after."

Board-level array processors are a niche that companies such as DEC aren't likely to pursue because it's a small market with relatively slow growth, he says. The government, medical and seismic markets are the main focus of the privately owned firm, which Sansouci says had revenue in the $10 million range last year and was "not greatly profitable."

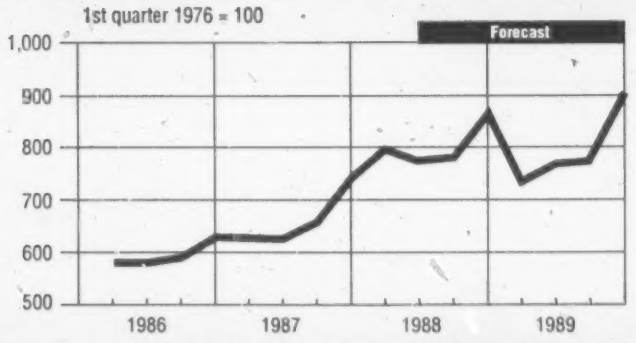
"I don't think that there's a general profitability in the industry," Sansouci notes. "But the board-level companies seem to be doing OK."□

U.S. economic indicators



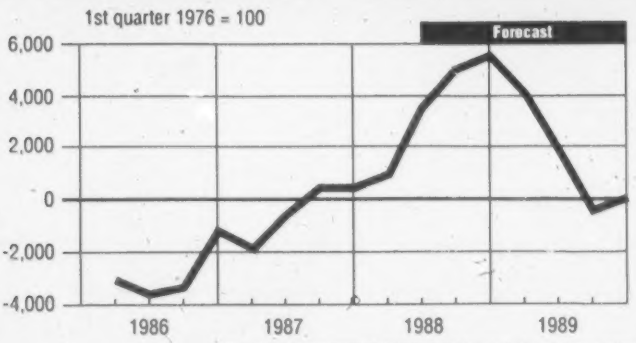
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Automatic test equipment — Revenue index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Automatic test equipment — Profits index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

U.S. production remains steady

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according to the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

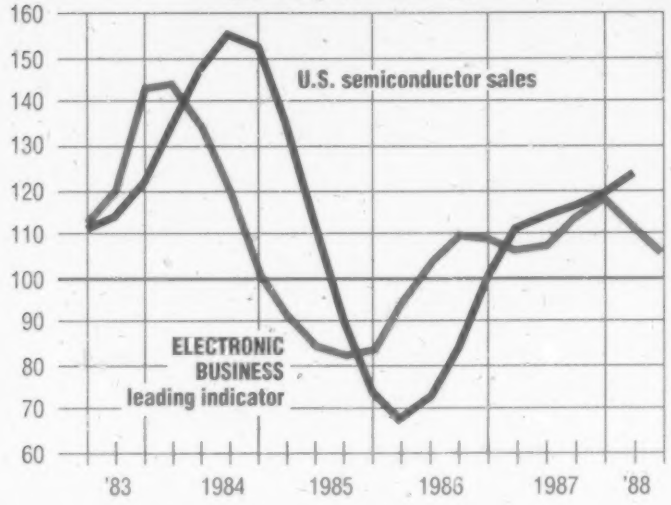
ATE revenue and profit

Manufacturers of automatic test equipment's first-quarter revenue reached $539 million, a 7.7% gain over the prior quarter and an even stronger 27.3% increase over the year-ago quarter's $423 million level. This year, the demand from computer and semiconductor manufacturers for automatic test equipment shows further signs of strengthening. Revenue is expected to rise a sharp 21.5% this year, followed by a 1.1% decrease next year.

ATE manufacturers returned to profitability during the second half of 1987. Not since the second quarter of 1985 has the ATE index shown positive earnings. Profits are expected to show healthy increases through 1988 with a slowdown forecast in mid-1989.

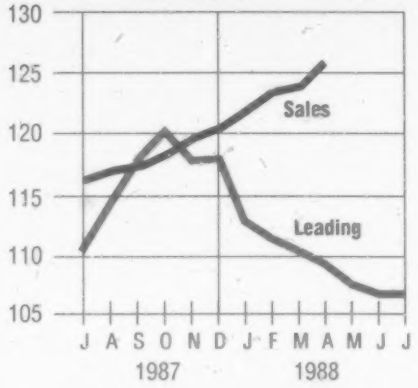
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton Mass. 02158, or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS indicator continued falling in March to 110.7 from a revised 112.1 in February. From its October 1987 turning point peak the indicator has fallen about 8%. By this July, the indicator is likely to have fallen another 4%. All in all, a mild beginning to a downturn in electronics.

Source: Cahners Economics

Electronics industry indicators this month

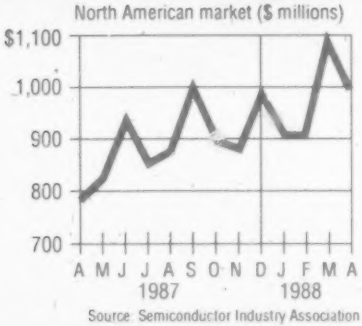
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, March)	110.7	112.1	107.2	112.0
U.S. semiconductor bookings ($ millions, 3-month average, April)	$1,214	$1,126	$955	$951
Weekly hours of semiconductor production workers (monthly average, March)	40.7	40.1	40.6	40.6
Electronic components leadtime index (1977 = 100, May)	114.3	105.2	101.5	100.7
Standard & Poor's semiconductor price index (1970 =10, monthly average, April)	60.1	59.2	69.2	65.5
Change in electronic components inventories ($ millions, SA, March)	+$52	+$142	-$36	+$46
Contract and orders for plant and equipment ($ billions, SA, March)	$37.8	$38.8	$32.8	$34.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales

North American market ($ millions)



Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio

Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio

Source: U.S. Commerce Department

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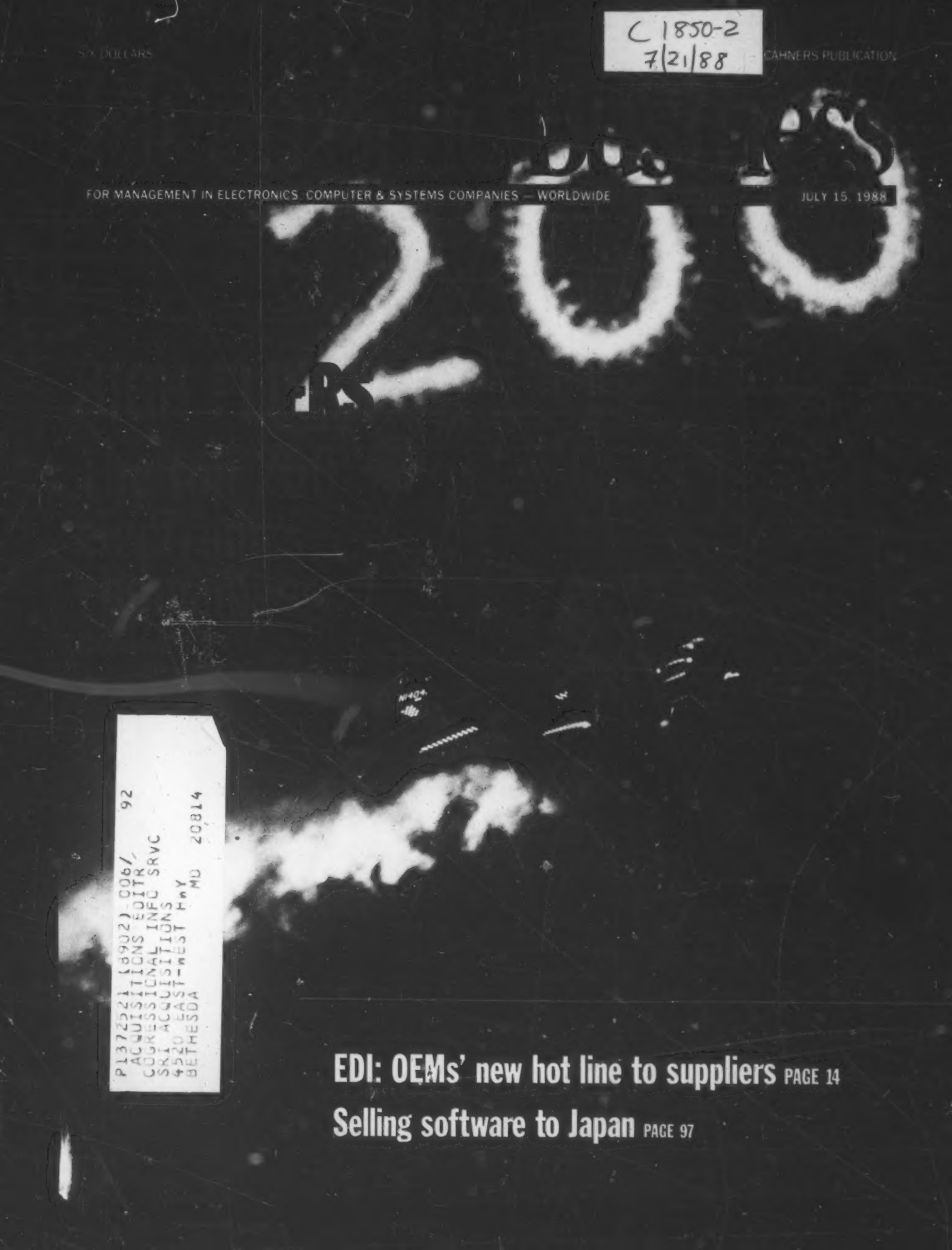
FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JULY 15, 1988



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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 14 JULY 15, 1988

Cover Story

THE ELECTRONIC BUSINESS 200

24 The 200: Sky-high and heading higher

After the exuberant highs of the early days and then the shocking reversal in 1985, the electronics industry is finally settling down. No longer driven by uncontrolled growth, the new, mature industry is more interested in expanding profits than revenue.

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Swapping purchasing data with suppliers via electronic data interchange is bringing OEMs savings of around 5% of sales. Just ask IBM, DEC and HP.

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By 1993, new LCD TVs will fuel a $730 million market for components. U.S. vendors are unlikely to benefit.

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Mastering the 200

This will be the fourth consecutive year that ELECTRONIC BUSINESS has published "The 200," our annual ranking of the top 200 publicly held companies in the American electronics industry.

To our knowledge, this is the only such ranking in the industry. We are proud of it, and proud of senior editor Linda Stallmann who — with the help of assistant editor Sherri Hartlen — sifts through hundreds of annual reports and other financial documents each year in order to compile it. After four years, the 200 has become a kind of fixture in the industry itself — a measure by which firms chart their progress or decline. And, as assistant managing editor Beth Karlin points out in her accompanying cover story, there are also indications in that list of where the industry may be headed in the year ahead.

This was, after all, the year of the bottom line. For the top 200 companies, profitability soared 50% in 1987, after two straight years of decline. What these figures suggest is that many U.S. companies are more concerned these days — and correctly so — about steady profits than they are about escalating revenue. Perhaps this is a sign of maturity.

In any event, we at ELECTRONIC BUSINESS were cheered by what we learned. So to celebrate the event, we even hired a biplane to write the number "200" in the skies over Massachusetts. Photos from that session accompany the article.

I guess what this all proves is that even though the U.S. electronics industry is fairly mature, we at ELECTRONIC BUSINESS are not above a little wackiness from time to time. We hope you enjoy our aerial acrobatics as much as we do.

EB's skywriter Paul Richter at the controls of his biplane

The 200 on a disk

We would be remiss too if we didn't point out that the 200, as usual, is available on a disk — in a handy IBM-compatible Lotus format or an Apple Macintosh Excel version. The price: $50, and cheap at that, if you're like most executives these days and like to fool around with numbers on a spreadsheet.

So, if you'd like to purchase a copy of the disk, please write to us at: "200 on a disk," ELECTRONIC BUSINESS, 275 Washington Street, Newton, Mass., 02158, and include a check or money order. We promise to process your order as quickly as possible.

AL FURST, Editor

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U.S. component suppliers miss the flat-panel TV show

By 1993, new LCD TVs will fuel a $730 million market for components. U.S. vendors are unlikely to benefit

Better liquid crystal displays (LCDs) are waking up the flat panel display market. The new screens are appearing not only in small computers, but increasingly in TVs, opening up major opportunities for suppliers of everything from interconnects and fine-line circuit boards to smaller, more efficient power supplies and the semiconductors that drive the displays.

Indeed, demand for flat-panel computer displays alone is pushing a market for materials and components that is growing anywhere from 20% to 25% annually, and which, according to Electronic Materials Report, a newsletter published in Los Altos, Calif., will be worth $730 million by 1993. The market for flat-panel TV display parts should be bigger still.

But so far, U.S. suppliers, constrained by America's pullout from consumer electronics, have scarcely a look-in. With Japan dominating the current LCD market, most suppliers of LCD materials and components are in Japan too.

One of the few U.S. manufacturers of LCD displays — Alphasil Inc. of Fremont, Calif. — sources its neon fluorescent backlighting, 320-pin-count boards and power supplies domestically, but says it has found no U.S. companies interested in supplying the ICs to drive the displays. Alphasil uses SMOS devices in 100-pin flatpacks. "There's potential to sell millions of those," says Thomas Stahl, Alphasil's director for sales and marketing. He notes that some producers from Taiwan have been in to talk to Alphasil about supplying drivers, spurred by some difficulty in Taiwan getting LCDs and drivers from Japan.

Yet, the market is there. Sales of sophisticated high information content flat-panel displays suitable for televisions and computers will reach $750 million this year, and nearly $2 billion by 1993, according to Stanford Resources Inc. of San Jose.

Sparking this enthusiasm are better liquid crystal displays. Back-lit LCDs have given reasonably priced laptop computers readable screens. Now the new neutral twist nematic (NTN) technology provides much higher contrast. Major suppliers are Hitachi Ltd., Toshiba Corp. and Seiko Epson.

"As the third-generation laptops come out in 1988, I think this NTN technology will be significantly preferred," says Thomas B. Martin, assistant vice president of the computer business unit of NEC Home Electronics (U.S.A.) Inc. in Wood Dale, Ill. NEC is expected to announce a portable with the new technology soon. Zenith Data Systems Corp. of Mount Prospect, Ill., and Grid Systems Corp. of Mountain View, Calif., have announced models.

Sony's 6-ineh color LCD TV

LCD televisions have made big strides, too. Antidumping duties have so far kept the new generation of 5-inch diagonal sets with better picture quality out of the United States. Sony Corp. recently announced it would have a 6-inch active matrix color set on the market by the end of the year, probably selling for under $800. Between 1.5 million and 2 million LCD TVs are expected to sell in Japan this year. Stanford Resources predicts sales of 10 million units by 1994, and 12-to-14 inch sizes by the mid-1990s. Already this year, the market for flat-panel displays for televisions will be bigger than for computers.

Unlike the early LCD televisions made by simpler technologies by watch and calculator companies, this new generation is being legitimized by the major Japanese electronics companies using active matrix thin-film transistor LCDs. The ultimate LCD, an active matrix device, can be as bright and as fast as a CRT, while still as flat and as low power as a conventional LCD.

While the Japanese consumer electronics giants are trying to bring their low-cost TV displays up to full size and quality, some U.S. companies are trying to bring their military active matrix displays down to prices civilians can afford.

Alphasil claims that by sticking strictly to standard IC industry materials and processes, it can make 5-inch by 5-inch CRT-quality displays now, and could make 10-inch by 10-inch displays by simply using a bigger mask aligner. Its displays, however, cost several thousand dollars each, and larger ones would cost tens of thousands. "When we get to 10 by 10," asserts marketing chief Stahl, "this [active matrix technology] could totally replace CRTs. That will be within five years."

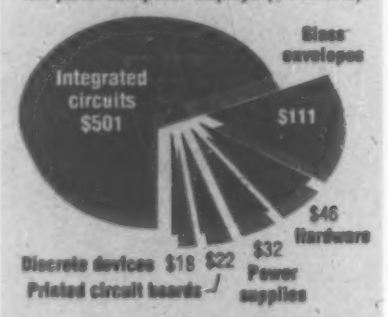
These various types of enhanced LCDs were only 10% of the $204 million market for displays for portable microcomputers last year, says Stanford Resources, but will jump to 45% of the $325 million 1989 market.

However, at least one U.S. electronic materials supplier does see big opportunity in the advanced LCD market. Corning Glass Works in Corning, N.Y., claims a 95% share of the growing Japanese market for the precision glass substrate for active matrix LCDs. Now the U.S. company is spending a third of its capital budget on the business, building a new plant in Japan and planning a research laboratory.

PAULA DOE

Flat-panel computer displays

Market for materials and components for flat-panel computer displays ($ millions)



Total 1993 market: $730 million

Source: Electronic Materials Report

1993 sales of parts for LCD TVs could be even higher than the $730 million for LCD computer screens

The 200 Sky-high and heading higher

The signs are positive. Total net income for the 200 leaders rose more than 50% to $41 billion after two years of declining growth

After the exuberant highs of the early days and then the shocking reversal in 1985, the electronics industry is finally settling down. No longer driven by uncontrolled growth, the new, mature industry is more interested in expanding profits than revenue. Today's cautious managers now see that the wild growth that turned so many start-ups into market leaders also ultimately turned many market leaders into losers.

This message is especially clear to executives whose companies have significantly increased their standings in this year's ELECTRONIC BUSINESS 200. Of the top 200 electronics companies ranked annually by this magazine, 98 firms advanced on the list this year over positions they previously held, and 21 companies joined the list.

"Profits are our No. 1 concern; size is way down the list," says E. Paul Eder, senior vice president of Anthem Electronics Inc., a leading distributor. "We would rather be a profitable midsized company than a large also-ran." This year, Anthem rose 36 slots on the ELECTRONIC BUSINESS 200 — to No. 162.

Eder echoes the sentiments of many executives. Indeed, in 1987 the industry's top performers kept both eyes sharply focused on the bottom line. As a result, total net income for the 200 leaders rose more than 50% to $41.0 billion after two years of declining growth, according to the ELECTRONIC BUSINESS 200. Electronics sales, by comparison, grew 7% to $298.5 billion for the calendar year. Since 1983, sales have risen 10.7% compounded annually. Net income, meanwhile, has increased 13.9% a year during the five years. ▷

BY BETH KARLIN and LINDA STALLMANN

The ELECTRONIC BUSINESS 200 is an exclusive report by ELECTRONIC BUSINESS magazine analyzing the financial statements of the 200 largest United States-based computer and electronics manufacturers. It is based on a careful analysis of hundreds of annual reports, 10-K Reports, interviews with company executives and estimates developed internally at the magazine. As such, the 200 — which only includes publicly held companies — provides an accurate gauge of the current status and future direction of the U.S. electronics industry.

And the prognosis is good. After spending two years streamlining operations, many of the ELECTRONIC BUSINESS 200 are well positioned for steady growth. And those that aren't are rapidly moving in that direction (see accompanying story). To see what the successful ones are doing right, ELECTRONIC BUSINESS closely studied the strategies of companies that vastly improved their standings in the ELECTRONIC BUSINESS 200 between 1986 and 1987.

For example, workstation maker Sun Microsystems Inc., with the largest sales growth rate this year, moved up 28 spots to No. 65. And Mark IV Industries Inc., a diversified manufacturer of industrial products — and next fastest growing — jumped 67 positions on our listing — to spot 113. Along the way, however, these companies didn't blindly sacrifice profits at the altar of revenue. Indeed, Sun's net income nearly doubled in 1987, while Mark IV's climbed almost 80%. "Our goal is to repeat what we have done well, learn from our mistakes and produce real returns at the operating unit level of a minimum of 15% of sales," says Sal H. Alfiero, Mark IV chairman.

Not by chance

Growth like this doesn't happen by chance. Rather, the winners have carefully orchestrated their successes. Key to that success is implementation of strict financial controls and an emphasis on profits.

"It takes strong concentration to focus on specific products or niches with profit potential when most of the competition is chasing sales volume," says Jerry Kalov, president of Dynascan Corp., a Chicago consumer electronics company that went from a $17 million loss from continuing operations in 1984 to a $6.6 million profit in 1987. "But if a product doesn't make a profit, we won't sell it." While that may seem obvious, many electronics companies owe their demise to aggressive marketing of products for all the wrong reasons — merely to expand their product lines, for example, or to get into new market segments without regard for profit potential.

No longer. In 1987, the emphasis on the bottom line forced many companies to completely rethink their corporate philosophies. While strate-

COMPOSITE PERFORMANCE OF THE ELECTRONIC BUSINESS 200

	1983	1984	Percentage change	1985	Percentage change	1986	Percentage change	1987	Percentage change
Electronic sales ($ billions)	$225.9	$256.2	+13.4%	$267.8	+4.5%	$279.2	+4.3%	$298.5	+6.9%
Total sales ($ billions)	$732.5	$776.5	+6.0%	$797.8	+2.7%	$641.7	-19.6%	$689.0	+7.4%
Net income ($ billions)	$37.4	$46.4	+24.1%	$35.4	-23.7%	$26.7	-24.6%	$41.0	+53.6%
Weighted averages:									
Return on equity	13.8%	16.5%	—	11.8%	—	10.2%	—	14.1%	—
Return on investment	10.2%	12.6%	—	8.7%	—	7.2%	—	10.2%	—
Cost of goods sold as a percentage of sales	70.0%	69.4%	—	70.3%	—	63.7%	—	61.5%	—
R&D as a percentage of sales	4.1%	4.2%		4.2%		5.0%		5.2%	—
Sales per employee	$97,300	$103,200	+6.1%	$110,800	+7.4%	$102,348	-7.6%	$113,450	+10.8%
Net income per employee	$5,100	$6,300	+23.5%	$5,000	-20.6%	$4,266	-14.7%	$6,663	+56.2%
5-year compound growth:									
Sales	+8.5%	+8.5%	—	+5.0%	—	+8.2%	—	+10.7%	—
Net income	+7.3%	+11.6%	—	+1.4%	—	+4.0%	—	+13.9%	—
Capital outlay to net cash flow after dividends	89.8%	96.0%	—	118.3%	—	97.9%	—	73.9%	—
Debt as a percentage of total capital	26.1%	23.5%	—	26.7%	—	29.9%	—	28.1%	—
Foreign sales as a percentage of sales	—	—	—	14.0%	—	25.4%	—	24.7%	—

gies vary from company to company, some clear patterns emerged among the winners. Fast-track managers tend to implement a combination of the following practices, tailoring their strategy to fit the individual needs of their companies. To continue to increase profits and revenue in an uncertain business climate, they have:

- Held tight reins on inventories
- Spread risk through diversification
- Expanded international sales and operating bases
- Consolidated manufacturing and trimmed workforces
- Pruned unprofitable or extraneous businesses
- Added product lines through internal development, joint ventures or acquisitions.

In some cases, firms vastly increased their size and ELECTRONIC BUSINESS 200 ranking largely by devouring new companies and adding sales to the corporate total. Computer and video-game manufacturer Atari Corp., for example, acquired the Federated Group Inc., a consumer electronics retail chain for $64 million. It is also seeking to acquire a semiconductor facility or, at least, to form an alliance with a chip company. And West Amherst, New York-based Mark IV purchased diversified Conrac Corp., for $185 million; and the Eagle Signal Controls Division of Wickes, for $16 million. In keeping with its strategy to manufacture only proprietary products, Mark IV at the same time got rid of its Engineered Magnetics business and its polystyrene and rubber-producing plants.

Strategic fit

San Jose-based Anthem expanded to the Northeast with the purchase of distributor Lionex Corp. And Olin Corp., Stamford, Conn., bought Aegis Inc., a supplier to the hybrid microelectronics industry, while divesting its firearm manufacturing business, among others. "Focusing on profit detractors continues to be a major strategic emphasis," says John W. Johnstone Jr., president of the Stamford, Conn., electronic materials and services, metals and chemicals company. "The issue of strategic fit must be addressed. There are no sacred cows at Olin."

The stepped-up pace of mergers and acquisitions in the electronics sector is also expected to continue. Dynascan, for one, intends to each year buy a company worth more than $25 million. In 1987, it completed the acquisition of Marantz Co., transforming the faltering audio equipment maker into a profitable business. The same year, Dynascan also sold off its industrial control and test equipment operations to concentrate solely on consumer electronics.

Despite Wall Street's generally negative attitude toward consumer electronics, Dynascan believes it can be a gold mine for those with the right strategy. "It's a terrific place to grow profitably by following selective nichemanship," says Kalov. For Dynascan, that "nichemanship" means never being a pioneer and never going up against the giants. "We do not want to be first; that requires substantial investment," explains Kalov. "We prefer to watch the market develop, begin to mature and learn from the mistakes of others." Dynascan's products include Cobra brand telephones, auto radar detectors, CB radios, stereo equipment and facsimile machines.

Nichemanship

These days, nichemanship can mean the difference between winning and losing. LSI Logic Corp., Milpitas, Calif., is betting that by transforming into an application-specific integrated circuit systems supplier it will cash in on the fast-growing ASIC business in the 1990s.

Mark IV, meanwhile, has targeted small industrial markets, from $20 million to $250 million, thus enabling them to steer clear of the giants. Also, says Alfiero, "the markets we pursue have significant technical and financial thresholds which may reduce the number of small competitors." Mark IV's businesses include everything from microprocessor controls to professional sound systems to telephone answering machines.

Niches don't have to be small, off-the-beaten-track segments. ▷

Can't tell an annual report by its cover

"Changing for the future," announces Cincinnati Milacron Inc. in big, bold red letters on the somber gray cover of its 1987 annual report. NBI Inc., meanwhile, declares: "Change equals opportunity" on the front of its latest report. Indeed, for those firms whose ELECTRONIC BUSINESS 200 standing dropped dramatically last year, change is indeed the name of the game.

In face of sales downturns, troubled companies dramatically restructured operations. They shut down or sold businesses, took painful writeoffs, trimmed workforces, brought in new managers and hoped for the best. "What we did in 1987 was demonstrate our ability to change," says Gary K. Willis, president of Foxboro Inc., a Foxboro, Mass., manufacturer of process control equipment.

GenRad Inc., a Concord, Mass. producer of test and measurement systems, closed the doors of its Semiconductor Test Division, which made high-end VLSI test systems. The cost: $32.5 million. Cleveland-based Eaton Corp. started selling its defense operations. Penn Central Corp., Cincinnati maker of telecommunications, defense and energy products, spun off its Sprague Technologies Inc. electronics businesses. And BRIntec Corp. put its printed circuit board and specialty telephone equipment businesses on the block.

"Restructuring actions were initiated as a strategic response to economic, technological and competitive changes," says Peter Petruchik, president of BRIntec, a Willimantic, Conn., maker of connectors and cable. BRIntec and other survivors of painful restructuring are predicting increased sales and profits in coming years. "We expect earnings growth averaging 12% to 15% a year and return on equity exceeding 20%," predicts Petruchik.

These new, leaner companies don't intend to get caught short again. "Restructuring can never be considered an accomplished fact," says Foxboro's Willis. "It must remain a dynamic process calculated to challenge our performance on a continuing basis." He adds: "The major efforts are behind us."

Compaq Computer Corp., for example, went up against no less of a giant than IBM with commodity products — and managed to surpass $1 billion in sales and $135 million in profits after only five years. Its niche is IBM-clone computers. Indeed, Compaq has become one of the industry's most remarkable success stories by beating IBM at its own game. Houston-based Compaq offers the same technology for less money and also steps in to fill the gaps when IBM leaves a market. By the end of 1987, boasts Rod Canion, Compaq president, "we emerged as a leader in high performance, industry-standard products worldwide."

Being a global leader is increasingly important. LSI Logic's international revenue, for example, last year grew twice as fast as total corporate revenue. And, says James M. McCoy, president of Maxtor Corp., San Jose: "Strengthening our position as a leading factor in the worldwide data storage marketplace is our primary goal." In 1987, the 5-year-old high-capacity disk maker broke ground for a new facility in Singapore and opened its first international direct sales office in Britain. "Boosted particularly by growth in Western Europe, international sales reached nearly $28 million, 16% of total revenues," according to McCoy.

Global leader

Atari, meanwhile, opened sales subsidiaries in Sweden, Spain, Australia and Mexico. The formerly beleaguered electronic game manufacturer has, under the leadership of Jack Tramiel, chairman, become a respected player in international markets for a variety of computer products, software and peripherals. Even its original video game line is making a comeback. Net sales outside North America accounted for 46% of total sales in 1987.

Atari UK reportedly has secured a 40% share of the 16-bit personal computer market in Great Britain. West Germany's Supreme Court keeps track of volumes of courtroom precedents and trial verdicts on Atari equipment. And in France, jazz artist Jean Michel Jarre composes on his Atari ST, taking advantage of Atari's musical instrument digital interface ports that allow musicians to connect synthesizers and instruments to their computers. "Our commitment to an international marketing strategy has resulted in a dramatic increase in European sales," says Tramiel. In fact, he says, European demand for Atari's new personal computers rose so sharply last year the firm was forced to postpone its marketing assault in the United States.

For the ELECTRONIC BUSINESS 200 as a whole, foreign sales accounted for about 25% of total corporate sales, about the same as last year but up dramatically from 14% two years ago. In many cases, unit sales growth was higher, but losses resulting from the weak dollar in many markets shrouded real growth.

For two straight years, foreign sales accounted for 25% of the 200's total revenue

Having a worldwide base not only moves engineering and manufacturing operations closer to customers, it also enables a company to compensate for a cyclical downturn in one geographical area with sales to another, economically stronger location. "Being global makes us less vulnerable to protectionism and it shields us, in part at least, from the effect of swings in currency values," says T. Kevin Dunnigan, president of components maker Thomas & Betts Corp. "Becoming truly multinational is a complex problem, but the long-term advantages make the effort worthwhile."

Those long-term advantages will be most noticeable on a firm's bottom line. And as the electronics industry grows from the wild child of the early years to the mature industry of the 1990s, the bottom line will continue to be the most important consideration. Mark IV chairman Alfiero spoke for many successful electronics executives in outlining his firm's objectives: "Our goals are to strengthen our balance sheet, to work with our existing operations to enhance profitability and to watch for opportunities to expand and excel." □

Notes to the 200

Revenue
Revenue includes sales of products, services and rentals, but excludes dividends, interest and other nonoperating revenue.

Profit
Profits are shown after taxes from continuing operations and before extraordinary items.

Return on equity
ROE is profits as a percentage of shareholders' equity — preferred stock, capital stock, surplus and retained earnings at year-end.

Return on investment
ROI is profits as a percentage of shareholders' equity plus short- and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold
This includes manufacturing costs of products, services and rentals sold, less depreciation.

Research and development
R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees
The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures to net cash flow
Capital expenditures are measured as a percentage of net profits plus depreciation, minus cash dividends paid.

Debt to total capital
This includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign sales
These include sales of operations outside the United States to unaffiliated customers and U.S. operations' export sales.

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 1 - 50

Rank 1987	Rank 1986	Company	Calendar year 1987 Electronics revenue ($ millions)	Calendar year 1987 Total revenue ($ millions)	Calendar year 1987 Net income ($ millions)	Fiscal year 1987 Total revenue ($ millions)	Fiscal year 1987 Net income ($ millions)	Return on equity	Return on investment
1	1	**IBM**	$54,217.0	$54,217.0	$5,258.0	$54,217.0	$5,258.0	13.7%	12.0%
2	2	**AT&T**	16,062.0	33,598.0	2,044.0	33,598.0	2,044.0	14.1%	9.1%
3	4	**GM Hughes Electronics**	10,481.0	10,481.0	521.1	10,481.0	521.1	7.4%	6.7%
4	5	**Digital Equipment**	10,391.1	10,391.1	1,284.2	9,389.4	1,137.4	18.1%	17.3%
5	7	**Unisys**	9,712.9	9,712.9	578.0	9,712.9	578.0	12.7%	8.7%
6	3	**General Electric**	9,514.0	39,315.0	2,915.0	39,315.0	2,119.0	12.9%	9.6%
7	6	**Xerox**	8,980.0	10,320.0	578.0	10,320.0	578.0	10.4%	7.5%
8	8	**Hewlett-Packard**	8,542.0	8,542.0	707.0	8,090.0	644.0	12.8%	10.6%
9	11	**Motorola**	6,707.0	6,707.0	308.0	6,707.0	308.0	10.2%	8.3%
10	12	**Honeywell**	6,679.3	6,679.3	253.7	6,679.3	253.7	11.3%	7.0%
11	14	**NCR**	5,640.7	5,640.7	419.3	5,640.7	419.3	19.4%	17.7%
12	13	**Texas Instruments**	5,594.5	5,594.5	256.9	5,594.5	256.9	11.4%	9.2%
13	10	**Lockheed**	5,241.6	11,321.0	436.0	11,321.0	436.0	20.9%	7.2%
14	15	**Raytheon**	4,740.0	7,659.4	445.1	7,659.4	445.1	24.1%	19.0%
15	17	**Eastman Kodak**	4,435.0	13,305.0	1,178.0	13,305.0	1,178.0	19.6%	14.3%
16	16	**Rockwell International**	4,423.7	11,936.5	678.6	12,123.4	635.1	19.2%	15.0%
17	19	**Tandy**	3,654.7	3,654.7	289.8	3,452.2	242.3	17.6%	15.3%
18	9	**Allied-Signal**	3,380.0	11,116.0	515.0	11,116.0	515.0	16.5%	9.1%
19	20	**TRW**	3,192.0	6,821.0	243.0	6,821.0	243.0	17.1%	9.4%
20	23	**Litton Industries**	3,191.7	4,735.5	151.3	4,419.7	138.1	13.1%	10.8%
21	22	**Wang Laboratories**	3,047.6	3,047.6	94.5	2,836.7	70.7	4.8%	3.1%
22	31	**Apple Computer**	3,041.3	3,041.3	280.4	2,661.1	217.5	26.0%	26.0%
23	28	**Martin Marietta**	2,960.2	5,165.1	230.7	5,165.1	230.7	25.4%	18.3%
24	26	**Ford Motor**	2,786.9	71,643.4	4,625.2	71,643.4	4,625.2	25.1%	21.0%
25	25	**3M**	2,698.0	9,429.0	918.0	9,429.0	918.0	18.1%	15.9%
26	21	**Control Data**	2,667.5	3,366.5	21.5	3,366.5	25.0	2.4%	1.7%
27	27	**ITT**	2,662.6	19,525.0	1,018.0	8,551.0	1,018.1	13.0%	9.5%
28	24	**Westinghouse Electric**	2,563.0	10,679.0	738.9	10,679.0	738.9	20.7%	12.4%
29	34	**Zenith Electronics**	2,362.7	2,362.7	-19.1	2,362.7	-19.1	-4.0%	-2.1%
30	29	**Harris**	2,100.1	2,100.1	92.2	2,079.0	84.5	8.6%	7.4%
31	36	**Pitney Bowes**	2,009.2	2,250.5	199.4	2,250.5	199.4	19.2%	13.5%
32	37	**Du Pont**	2,000.0	30,468.0	1,786.0	30,468.0	1,786.0	12.5%	9.4%
33	33	**Boeing**	1,980.0	15,355.0	480.0	15,355.0	480.0	9.6%	9.1%
34	40	**AMP**	1,912.0	2,317.8	249.7	2,317.8	249.7	18.5%	16.3%
35	48	**Intel**	1,907.1	1,907.1	175.5	1,907.1	175.5	13.4%	8.5%
36	39	**National Semiconductor**	1,877.7	1,877.7	-28.8	1,867.9	-28.8	-3.2%	-2.9%
37	38	**McDonnell Douglas**	1,810.0	13,344.5	313.0	13,344.5	313.0	10.5%	6.9%
38	32	**GTE**	1,784.2	15,421.0	1,118.8	15,421.0	1,082.0	11.3%	5.4%
39	45	**Emerson Electric**	1,770.0	6,317.5	482.8	6,170.3	467.2	17.3%	12.9%
40	41	**Singer**	1,618.0	1,902.7	23.4	1,902.7	23.4	3.7%	1.5%
41	52	**Amdahl**	1,505.2	1,505.2	142.0	1,505.2	142.0	18.5%	15.4%
42	47	**Avnet**	1,482.0	1,670.7	37.3	1,547.1	22.8	3.5%	2.6%
43	42	**United Technologies**	1,420.0	17,170.2	591.7	17,170.2	591.7	10.3%	7.2%
44	44	**Tektronix**	1,388.9	1,388.9	25.7	1,395.9	51.2	6.1%	5.7%
45	46	**Data General**	1,303.9	1,303.9	-75.9	1,274.3	-82.9	-14.1%	-11.7%
46	50	**Perkin-Elmer**	1,233.0	1,377.8	-9.6	1,333.6	-18.2	-2.6%	-2.0%
47	69	**Compaq Computer**	1,224.1	1,224.1	136.3	1,224.1	136.3	34.1%	24.8%
48	43	**Teledyne**	1,222.0	3,216.8	377.2	3,216.8	377.2	19.1%	14.9%
49	49	**Northrop**	1,124.5	6,052.5	94.2	6,052.5	94.2	9.9%	5.0%
50	57	**General Instrument**	1,104.0	1,104.0	53.6	787.9	18.5	4.0%	2.8%

NA = not available

NM = not meaningful

Fiscal year 1987				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
38.9%	10.0%	$139.3	$13.5	9.5%	3.6%	70.2%	12.5%	54.0%	12/87
38.2%	7.3%	110.9	6.7	NA	NA	82.3%	35.2%	NA	12/87
72.3%	4.0%	104.8	5.2	NA	NA	56.1%	9.7%	11.6%	12/87
22.3%	10.8%	85.0	10.3	19.3%	22.2%	47.6%	4.2%	47.0%	6/87
32.5%	6.1%	105.0	6.2	18.9%	33.4%	75.4%	31.6%	43.6%	12/87
71.5%	3.1%	130.2	7.0	7.7%	3.4%	71.5%	25.4%	23.4%	12/87
45.1%	7.0%	104.2	5.8	5.3%	47.8%	97.3%	27.9%	44.9%	12/87
42.6%	11.1%	98.7	7.9	14.1%	11.0%	54.8%	17.5%	49.0%	10/87
53.2%	7.8%	68.6	3.2	12.1%	12.6%	91.5%	19.4%	43.8%	12/87
66.8%	4.3%	84.7	3.2	11.3%	6.6%	53.0%	38.4%	20.6%	12/87
48.8%	6.3%	91.0	6.8	9.9%	12.4%	62.4%	9.0%	54.6%	12/87
71.5%	7.7%	71.7	3.3	5.3%	12.3%	82.0%	19.7%	31.5%	12/87
89.7%	4.8%	114.0	4.4	15.1%	16.1%	53.9%	65.5%	8.0%	12/87
76.9%	3.5%	100.1	5.8	8.0%	8.0%	64.6%	21.1%	17.1%	12/87
52.7%	7.5%	107.0	9.5	4.2%	0.3%	103.2%	26.9%	42.8%	12/87
74.8%	3.5%	104.4	5.5	10.4%	13.9%	50.2%	21.6%	15.1%	9/87
47.4%	0.0%	88.5	6.2	13.5%	1.6%	34.3%	12.6%	1.6%	6/87
77.0%	6.0%	96.4	4.5	17.8%	12.9%	108.6%	44.6%	19.3%	12/87
73.1%	4.8%	87.6	3.1	8.9%	7.4%	100.0%	45.4%	25.7%	12/87
76.1%	4.7%	81.5	2.5	2.1%	-14.0%	84.7%	17.7%	22.7%	7/87
27.1%	7.5%	93.6	2.3	19.6%	-8.0%	42.8%	33.8%	40.1%	6/87
46.1%	7.2%	475.2	38.8	35.5%	28.8%	31.6%	0.0%	27.1%	9/87
76.5%	4.3%	73.8	3.3	11.2%	16.9%	77.9%	27.9%	NA	12/87
77.2%	3.5%	204.5	13.2	14.1%	NM	51.7%	16.5%	NA	12/87
52.5%	6.6%	115.0	11.2	7.4%	7.8%	77.9%	12.1%	39.8%	12/87
63.3%	11.6%	97.6	0.7	1.1%	-30.6%	73.8%	29.6%	20.0%	12/87
77.4%	2.2%	71.3	8.5	-11.7%	7.7%	37.2%	27.2%	52.4%	12/87
70.3%	2.0%	94.9	6.6	1.8%	10.5%	51.0%	39.8%	20.6%	12/87
83.7%	4.4%	67.5	-0.5	13.8%	NM	247.3%	47.7%	17.2%	12/87
58.8%	5.7%	85.6	3.5	4.8%	1.1%	39.7%	13.8%	14.7%	6/87
31.7%	2.9%	76.4	6.8	10.0%	17.5%	88.9%	29.5%	19.5%	12/87
49.0%	4.0%	217.4	12.7	1.0%	14.8%	100.1%	25.0%	49.8%	12/87
84.8%	5.4%	112.8	3.5	-11.2%	10.5%	96.2%	5.1%	40.9%	12/87
56.8%	8.8%	105.4	11.3	13.3%	16.0%	57.6%	12.2%	52.3%	12/87
45.7%	13.6%	99.3	9.1	16.2%	42.4%	86.9%	36.5%	38.8%	12/87
62.1%	11.7%	64.0	-1.0	11.1%	NM	79.2%	11.3%	42.1%	5/87
76.7%	4.9%	118.7	2.8	12.5%	7.8%	86.9%	34.9%	21.4%	12/87
41.3%	1.6%	95.8	6.7	6.0%	5.9%	116.4%	52.1%	13.3%	12/87
62.8%	3.1%	89.8	6.8	10.1%	7.6%	29.3%	25.3%	20.0%	9/87
92.2%	2.0%	68.0	0.8	9.0%	-18.6%	109.5%	60.0%	NA	12/87
47.8%	11.9%	198.0	18.7	26.6%	96.1%	66.2%	17.1%	44.3%	12/87
73.5%	0.0%	162.8	2.4	6.8%	-16.5%	146.5%	25.7%	NA	6/87
73.2%	5.1%	90.4	3.1	6.5%	5.3%	156.2%	29.4%	24.5%	12/87
39.8%	14.3%	81.6	3.0	3.1%	-6.7%	30.2%	6.0%	42.2%	5/87
47.8%	12.5%	81.2	-5.3	9.6%	NM	576.1%	16.8%	45.0%	9/87
52.6%	10.5%	94.5	-1.3	5.2%	NM	492.2%	22.8%	46.2%	7/87
56.8%	3.8%	306.0	34.1	NA	NA	71.4%	27.2%	26.0%	12/87
73.5%	2.7%	72.5	8.5	-3.6%	6.9%	19.2%	21.8%	7.9%	12/87
84.4%	2.7%	125.6	2.0	19.6%	79.9%	103.4%	49.3%	NA	12/87
76.5%	3.1%	48.3	1.1	-2.9%	-28.1%	103.7%	29.4%	16.2%	2/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 51-100

Rank 1987	Rank 1986	Company	Calendar year 1987 Electronics revenue ($ millions)	Calendar year 1987 Total revenue ($ millions)	Calendar year 1987 Net income ($ millions)	Fiscal year 1987 Total revenue ($ millions)	Fiscal year 1987 Net income ($ millions)	Return on equity	Return on investment
51	53*	Grumman	$1,089.5	$3,375.3	$27.1	$3,375.3	$27.1	1.8%	1.2%
52	60	Tandem Computers	1,079.7	1,079.7	102.2	1,035.5	105.6	14.6%	14.4%
53	66	Seagate Technology	1,075.7	1,075.7	115.3	958.1	139.7	39.5%	21.3%
54	51	E-Systems	1,067.2	1,227.2	60.4	1,227.2	60.4	14.1%	11.8%
55	55	General Dynamics	1,050.0	9,344.0	437.3	9,344.0	437.3	27.3%	21.6%
56	56	Varian Associates	1,032.9	1,032.9	-4.1	982.8	21.4	4.9%	4.1%
57	71	Advanced Micro Devices	997.1	997.1	-48.1	997.1	-48.1	-7.3%	-6.0%
58	58	Prime Computer	960.9	960.9	64.8	960.9	64.8	12.9%	6.1%
59	59	Chrysler	946.0	26,276.5	1,289.7	26,276.5	1,289.7	19.8%	12.7%
60	53	Gould	933.4	933.4	25.0	933.4	25.0	5.2%	3.0%
61	68	Loral	920.0	1,244.7	69.6	690.0	57.5	15.8%	13.6%
62	61	Johnson Controls	811.0	2,806.8	96.6	2,676.8	89.6	11.6%	8.2%
63	63	Emerson Radio	792.4	792.4	-9.8	810.1	26.6	27.7%	9.0%
64	35	Eaton	775.0	3,137.9	206.2	3,137.9	206.2	19.2%	10.8%
65	93	Sun Microsystems	755.9	755.9	48.0	537.5	36.3	15.1%	9.0%
66	67	Storage Technology	750.0	750.0	19.0	750.0	19.0	8.1%	3.1%
67	70	SmithKline Beckman	704.1	4,328.8	570.1	4,328.8	570.1	36.0%	20.4%
68	73	Cray Research	687.3	687.3	147.1	687.3	147.1	24.1%	20.2%
69	54	Contel	660.0	2,905.5	77.7	2,905.5	77.7	5.4%	2.1%
70	64	General Signal	641.2	1,603.0	69.4	1,603.0	69.4	7.6%	6.8%
71	72	Intergraph	641.1	641.1	69.9	641.1	69.9	12.3%	12.2%
72	77	Monsanto	634.0	7,639.0	436.0	7,639.0	436.0	11.2%	7.3%
73	80	SCI Systems	614.7	614.7	17.0	552.9	16.0	12.0%	5.0%
74	—	Computer Associates	604.7	604.7	79.2	309.3	36.5	16.6%	11.1%
75	79	Computervision†	564.0	564.0	19.5	564.0	19.5	NA	NA
76	89	Western Digital	563.1	563.1	44.5	462.5	42.8	21.2%	20.3%
77	78	Arrow Electronics	562.4	562.4	-15.8	562.4	-15.8	-16.4%	-10.0%
78	86	Apollo Computer	553.7	553.7	21.7	553.7	21.7	9.6%	6.3%
79	85	Medtronic	537.0	608.0	83.5	502.0	73.8	19.1%	17.4%
80	74	Corning Glass Works	522.0	2,083.7	203.3	2,083.7	203.3	13.2%	10.3%
81	81	Scientific-Atlanta	513.9	513.9	28.4	495.3	24.3	12.0%	11.6%
82	115	Atari	493.2	493.2	44.2	493.2	44.2	26.3%	14.2%
83	82	United Telecommunications	476.3	2,982.2	-51.5	2,982.2	-51.5	-3.3%	-1.1%
84	88	Tyler	475.4	1,099.5	16.8	1,099.5	16.8	9.4%	5.8%
85	84	Xidex	460.0	579.7	-9.2	572.8	-44.5	-11.5%	-8.4%
86	114	Microsoft	456.7	456.7	92.9	345.9	71.9	30.1%	29.2%
87	—	Raychem	447.2	1,016.4	89.8	944.4	73.6	12.9%	10.5%
88	75	M/A-COM	437.3	437.3	-27.3	436.1	-29.3	-10.9%	-7.5%
89	—	Sprague Technologies	437.3	437.3	3.6	437.3	3.6	1.1%	1.0%
90	91	Molex	437.1	437.1	50.2	386.8	43.4	13.7%	13.3%
91	96	EG&G	420.4	1,247.5	55.5	1,247.5	55.5	20.4%	15.7%
92	83	Textron	410.0	5,388.4	261.1	5,388.4	261.1	11.3%	6.9%
93	116	LTV	396.0	7,581.8	502.6	7,581.8	502.6	-24.6%	-25.0%
94	106	Lotus Development	395.6	395.6	72.0	395.6	72.0	35.7%	30.0%
95	131	Wyse Technology	392.8	392.8	25.4	260.0	18.1	19.6%	18.2%
96	119	Emhart	392.0	2,454.5	106.5	2,454.5	106.5	12.7%	7.6%
97	95	Analog Devices	390.7	390.7	22.3	370.4	18.7	6.1%	5.6%
98	100	Teradyne	377.7	377.7	-21.5	377.7	-21.5	-7.7%	-6.5%
99	158	MiniScribe	362.5	362.5	28.1	362.5	28.1	27.8%	14.0%
100	111	Dover	360.6	1,585.5	111.7	1,585.5	111.7	16.6%	13.1%

* 1986 rank readjusted
† bought by Prime Feb. 12, 1988
NA = not available
NM = not meaningful

Fiscal year 1987				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
89.4%	1.4%	$100.2	$0.8	10.4%	-21.4%	187.8%	34.2%	9.3%	12/87
29.6%	10.5%	147.8	15.1	27.1%	0.0%	90.3%	1.4%	44.4%	9/87
68.6%	3.5%	59.9	8.7	88.3%	82.5%	46.8%	46.1%	43.6%	6/87
81.4%	2.7%	79.1	3.9	11.8%	8.2%	68.3%	16.1%	6.6%	12/87
78.9%	3.6%	88.7	4.2	9.7%	20.7%	48.9%	21.1%	NA	12/87
65.0%	8.2%	82.6	1.8	8.4%	-3.0%	87.3%	16.6%	23.6%	9/87
41.1%	24.9%	55.3	-2.7	19.5%	NM	141.8%	17.7%	27.2%	12/87
38.2%	11.4%	109.0	7.3	17.1%	7.6%	69.0%	52.3%	48.0%	12/87
77.7%	3.0%	186.4	9.1	21.2%	NM	65.8%	35.8%	9.9%	12/87
49.4%	10.1%	92.2	2.5	4.0%	-17.2%	51.2%	42.2%	38.0%	12/87
73.9%	4.6%	47.6	4.0	19.6%	17.2%	45.9%	13.9%	6.2%	3/87
76.4%	1.8%	99.5	3.3	16.4%	10.7%	70.0%	29.6%	14.4%	9/87
88.1%	0.1%	1,012.6	33.3	56.0%	145.2%	14.6%	67.4%	NA	3/87
68.0%	3.7%	87.4	5.7	7.2%	NM	58.6%	43.6%	22.7%	12/87
46.1%	12.9%	128.5	8.7	474.4%	NM	124.0%	40.5%	32.0%	6/87
59.5%	8.0%	84.6	2.1	-7.0%	-21.8%	183.5%	61.7%	26.4%	12/87
31.0%	9.8%	119.2	15.7	10.4%	4.6%	29.6%	43.3%	38.1%	12/87
11.4%	15.8%	159.5	34.1	37.2%	50.6%	18.3%	16.1%	37.0%	12/87
30.2%	0.0%	133.8	3.6	8.0%	-11.3%	173.6%	60.8%	NA	12/87
61.3%	6.6%	83.8	3.6	-0.2%	-8.4%	42.1%	11.5%	20.9%	12/87
45.1%	10.5%	101.8	11.1	32.7%	40.0%	44.8%	1.0%	36.9%	12/87
53.4%	8.1%	153.6	8.8	3.8%	5.8%	55.9%	35.0%	NA	12/87
93.0%	0.0%	83.0	2.4	43.8%	31.3%	104.8%	58.3%	24.8%	6/87
-8.8%	13.0%	114.6	13.5	48.3%	65.8%	16.4%	32.8%	48.7%	3/87
NA	NA	NA	NA	11.6%	-9.7%	NA	NA	NA	12/87
59.3%	8.1%	138.5	12.8	69.2%	43.2%	66.7%	4.1%	36.9%	6/87
79.4%	0.0%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	0.0%	12/87
44.5%	11.0%	138.4	5.4	98.2%	135.4%	84.3%	34.2%	51.8%	12/87
28.4%	8.4%	101.4	14.9	11.9%	8.7%	32.3%	8.8%	41.5%	4/87
60.6%	4.8%	81.7	8.0	5.7%	22.2%	76.6%	22.3%	31.3%	12/87
69.0%	4.1%	147.9	7.2	8.0%	11.4%	18.9%	3.5%	0.2%	6/87
60.8%	3.7%	120.6	10.8	19.1%	16.2%	8.4%	46.2%	45.9%	12/87
-18.9%	0.0%	127.9	-2.2	4.3%	NM	218.9%	67.1%	NA	12/87
74.8%	0.0%	146.6	2.2	11.0%	13.0%	76.5%	38.4%	NA	12/87
76.7%	2.0%	83.0	-6.5	42.6%	NM	-150.0%	26.7%	29.9%	6/87
19.2%	11.0%	190.5	39.6	69.8%	83.0%	73.0%	2.9%	42.3%	6/87
42.0%	7.3%	95.4	7.4	12.0%	14.6%	65.7%	18.8%	61.6%	6/87
69.0%	5.6%	64.6	-4.3	4.5%	NM	-295.1%	31.4%	21.5%	9/87
74.1%	4.8%	50.8	0.4	NA	NA	76.2%	5.1%	38.2%	12/87
46.2%	5.5%	77.9	8.7	18.4%	16.0%	65.2%	3.3%	68.4%	6/87
78.9%	1.4%	55.4	2.5	8.3%	6.9%	29.8%	22.9%	7.1%	12/87
78.5%	2.2%	88.3	4.3	22.1%	30.6%	65.3%	39.2%	27.5%	12/87
81.7%	0.0%	157.3	10.4	9.7%	26.5%	45.7%	-1.5%	NA	12/87
13.4%	14.8%	188.4	34.3	356.3%	NM	30.3%	15.7%	52.3%	12/87
66.4%	5.3%	128.7	9.0	102.7%	NM	36.8%	7.5%	0.2%	3/87
64.5%	1.6%	8.0	3.5	7.5%	5.8%	64.7%	40.2%	40.9%	12/87
37.3%	15.1%	71.2	3.6	16.3%	13.6%	82.1%	8.3%	0.5%	10/87
50.2%	16.3%	80.4	-4.6	12.8%	NM	374.1%	15.9%	36.4%	12/87
71.3%	5.5%	72.9	5.7	135.5%	NM	128.2%	49.6%	36.1%	12/87
65.2%	2.9%	90.1	6.3	8.9%	4.5%	28.8%	21.1%	24.0%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

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FINANCIAL TABLES

Ranking: 101-150

Rank 1987	Rank 1986	Company	Calendar year 1987 Electronics revenue ($ millions)	Calendar year 1987 Total revenue ($ millions)	Calendar year 1987 Net income ($ millions)	Fiscal year 1987 Total revenue ($ millions)	Fiscal year 1987 Net income ($ millions)	Return on equity	Return on investment
101	94	Diebold	$360.0	$439.1	$35.8	$439.1	$35.8	10.5%	10.3%
102	105	Dynatech	348.9	348.9	21.4	304.7	23.2	18.8%	13.9%
103	99	AM International	342.0	1,199.0	1.6	1,162.8	2.3	0.9%	0.4%
104	120	Nashua	341.0	865.1	26.6	865.1	26.6	12.8%	9.5%
105	109	Marshall Industries	340.3	340.3	10.6	286.6	5.1	9.4%	5.1%
106	—	MAI Basic Four	334.3	334.3	23.8	321.0	22.8	29.3%	17.6%
107	90	Dataproducts	334.2	334.2	-3.6	338.8	9.0	4.1%	3.3%
108	126	Polaroid	330.0	1,763.9	116.1	1,763.9	116.1	10.8%	8.9%
109	65	Penn Central	325.0	1,421.4	34.8	1,421.4	34.8	2.1%	1.9%
110	98	Datapoint	320.7	320.7	15.1	312.1	-58.5	-32.2%	-20.1%
111	113	Augat	313.2	313.2	11.5	313.2	11.5	5.4%	4.8%
112	102	DSC Communications	312.4	312.4	14.6	312.4	14.6	6.9%	5.1%
113	180	Mark IV Industries	311.2	394.9	16.2	291.5	10.2	25.3%	3.9%
114	97	Cubic	311.0	357.8	7.7	361.8	7.9	7.1%	4.1%
115	123	Eli Lilly	308.0	3,643.8	410.5	3,643.8	410.5	13.5%	11.3%
116	174	Genicom	302.2	302.2	12.6	302.2	12.6	21.5%	7.5%
117	110	Premier Industrial	296.0	486.8	56.0	459.0	48.3	18.1%	17.6%
118	—	Westmark International	291.9	291.9	-7.2	291.9	-7.2	-3.2%	-3.1%
119	168	AST Research	289.8	289.8	3	206.0	13.0	13.1%	13.1%
120	127	Tandon	289.1	289.1	17.1	289.1	17.1	18.3%	15.2%
121	138	Micropolis	288.3	288.3	27.2	288.3	27.2	19.6%	12.7%
122	148	Bolt Beranek and Newman	279.8	279.8	-6.1	233.8	-8.0	-9.4%	-8.7%
123	149	AVX	271.9	271.9	15.8	271.9	15.8	8.5%	4.8%
124	121	Square D	270.5	1,484.2	110.0	1,484.2	110.0	16.2%	12.4%
125	103	TIE/communications	270.2	270.2	-11.1	250.2	-11.1	-6.4%	-5.1%
126	124	Recognition Equipment	269.2	269.2	10.1	264.7	11.2	8.4%	5.6%
127	136	Diasonics	267.6	267.6	15.2	267.6	15.2	14.4%	12.1%
128	104	Foxboro	267.3	504.4	-96.9	504.4	-96.9	-51.5%	-40.1%
129	141	Ashton-Tate	267.3	267.3	43.1	267.3	43.1	24.1%	23.0%
130	108	Savin	267.2	356.3	115.0	356.3	0.1	-0.2%	0.1%
131	129	Figgie International	266.0	1,022.7	49.3	1,022.7	49.3	15.3%	11.0%
132	134	Wyle Laboratories	265.4	368.0	5.8	368.0	5.8	6.5%	4.3%
133	118	Watkins-Johnson	264.3	264.3	17.1	264.3	17.1	14.7%	12.0%
134	151	LSI Logic	262.1	262.1	10.7	262.1	10.7	3.5%	2.2%
135	125	CTS	261.1	261.1	10.5	261.1	10.5	8.3%	6.3%
136	107	Kollmorgen	260.0	301.0	0.3	301.0	0.3	0.4%	0.2%
137	117	Bally Manufacturing	255.0	1,730.1	-6.4	1,730.1	-6.4	-1.1%	-0.3%
138	139	Gerber Scientific	254.8	254.8	28.0	223.9	21.1	13.1%	11.7%
139	133	Cooper Industries	251.0	3,585.8	173.8	3,585.8	173.8	10.9%	6.8%
140	153	Bell Industries	250.0	407.1	4.5	357.1	3.3	3.1%	2.4%
141	157	Ball	242.2	1,054.1	66.3	1,054.1	66.3	16.7%	12.2%
142	184	Maxtor	239.4	239.4	16.1	175.3	22.4	22.0%	10.7%
143	137	Pioneer-Standard	238.5	238.5	4.1	212.2	1.8	6.3%	2.2%
144	194	Applied Magnetics	235.7	235.7	17.5	211.9	14.2	9.5%	9.2%
145	132	Reynolds & Reynolds	234.0	572.1	19.5	562.7	21.2	11.0%	7.1%
146	112	Paradyne	232.6	232.6	-2.6	232.6	-2.6	-1.8%	-1.1%
147	147	Andrew	229.0	229.0	4.2	223.2	3.8	2.5%	2.2%
148	135	Sundstrand	228.0	1,365.5	34.6	1,365.5	34.6	5.8%	3.7%
149	152	Measurex	227.4	227.4	26.8	227.4	26.8	15.8%	15.2%
150	130	BRIntec	222.2	293.7	5.9	293.7	5.9	10.0%	4.0%

NA = not available NM = not meaningful

Fiscal year 1987				Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
64.6%	3.3%	$90.0	$7.3	0.5%	-2.9%	29.7%	2.0%	7.0%	12/87
40.8%	9.0%	98.3	7.5	23.7%	30.2%	37.3%	26.3%	25.4%	3/87
63.8%	4.2%	97.3	0.2	14.1%	NM	92.9%	54.8%	38.0%	7/87
64.9%	0.8%	128.8	4.0	7.7%	NM	67.0%	26.0%	0.5%	12/87
75.1%	0.0%	260.6	4.7	19.4%	NM	143.7%	45.7%	NA	5/87
44.6%	4.0%	98.7	7.0	5.1%	NM	47.6%	39.9%	64.1%	9/87
64.5%	6.6%	86.9	2.3	3.2%	13.8%	60.2%	19.3%	26.8%	3/87
49.9%	8.1%	129.1	8.5	6.4%	37.6%	75.4%	17.2%	42.8%	12/87
80.2%	0.7%	90.5	2.2	-14.8%	-23.3%	41.7%	10.7%	17.6%	12/87
57.8%	6.2%	113.5	-21.3	-9.3%	NM	-74.1%	37.4%	79.2%	7/87
68.1%	5.1%	82.4	3.0	8.8%	-11.2%	136.0%	11.5%	18.0%	12/87
49.6%	13.1%	122.8	5.7	35.5%	16.8%	53.5%	26.8%	14.4%	12/87
62.8%	2.2%	58.3	2.0	67.5%	70.9%	31.2%	84.7%	10.6%	2/87
73.4%	1.4%	80.4	1.8	4.3%	-13.3%	118.8%	41.9%	NA	9/87
30.7%	12.8%	141.8	16.0	4.2%	-0.1%	108.8%	16.6%	35.9%	12/87
64.8%	4.9%	84.2	3.5	NA	NA	37.8%	65.1%	32.0%	12/87
51.5%	0.6%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	0.0%	5/87
55.6%	9.6%	96.6	-2.4	NA	NA	366.7%	2.7%	28.0%	12/87
56.1%	5.4%	151.7	9.6	249.5%	NM	35.0%	0.0%	19.6%	6/87
70.4%	3.6%	82.4	4.9	13.9%	1.7%	52.2%	16.8%	75.0%	12/87
72.7%	7.5%	120.9	11.4	54.3%	206.9%	52.0%	35.0%	69.7%	12/87
52.8%	6.1%	87.6	-3.0	27.6%	NM	489.1%	7.5%	NA	6/87
66.0%	3.1%	36.3	2.1	17.7%	38.8%	91.9%	43.9%	43.0%	12/87
60.8%	3.0%	75.0	5.6	7.9%	8.9%	37.3%	23.4%	19.0%	12/87
66.7%	8.6%	166.8	-7.4	7.8%	NM	-187.6%	20.3%	30.3%	12/87
53.5%	4.4%	90.7	3.8	18.7%	NM	96.6%	33.1%	49.1%	10/87
58.4%	6.9%	177.2	10.1	19.5%	10.8%	33.8%	16.4%	3.1%	12/87
60.7%	10.0%	72.1	-13.8	-3.5%	NM	-45.2%	22.1%	52.8%	12/87
11.6%	10.5%	213.9	34.5	60.8%	74.0%	11.2%	4.2%	30.3%	1/88
57.8%	1.3%	176.4	0.1	-4.2%	NM	4.5%	159.7%	10.8%	12/87
72.8%	1.3%	62.4	3.0	8.7%	14.1%	42.8%	27.9%	NA	12/87
76.7%	0.0%	169.5	2.7	13.4%	NM	49.1%	33.5%	NA	1/88
58.7%	6.4%	84.4	5.5	11.1%	10.7%	47.0%	18.2%	19.0%	12/87
48.7%	11.0%	113.0	4.6	120.8%	NM	339.5%	38.3%	14.6%	12/87
75.5%	2.0%	39.3	1.6	4.7%	3.8%	63.7%	24.3%	19.7%	12/87
66.9%	4.7%	77.2	0.1	4.4%	-50.6%	124.2%	45.6%	11.4%	12/87
61.6%	0.9%	58.8	-0.2	6.1%	NM	168.1%	71.2%	NA	12/87
46.8%	7.4%	124.4	11.7	14.2%	44.0%	41.4%	10.3%	47.0%	4/87
64.0%	0.0%	83.0	4.0	8.4%	5.2%	44.6%	37.3%	20.6%	12/87
75.0%	0.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	NA	6/87
77.1%	1.3%	152.8	9.6	3.4%	13.9%	153.5%	27.1%	NA	12/87
[illegible]%	6.7%	90.9	11.6	NA	NA	66.1%	51.6%	16.0%	3/87
75.3%	0.0%	253.6	2.2	17.5%	-4.4%	61.5%	65.0%	NA	3/87
64.9%	9.2%	30.5	2.0	18.0%	9.8%	98.8%	3.2%	46.5%	9/87
54.2%	2.2%	98.7	3.7	20.6%	22.1%	98.0%	35.4%	6.8%	9/87
53.0%	8.2%	74.7	-0.8	2.3%	NM	52.0%	37.0%	17.9%	12/87
63.1%	4.7%	97.0	1.7	9.4%	-23.3%	70.3%	13.8%	40.7%	9/87
60.4%	5.2%	96.2	2.4	7.3%	-13.0%	78.4%	36.5%	22.2%	12/87
52.9%	7.3%	89.5	10.6	14.0%	NM	22.1%	3.5%	59.4%	11/87
76.1%	1.5%	75.1	1.5	4.0%	NM	73.5%	60.3%	15.8%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 151-200

Rank 1987	Rank 1986	Company	Calendar year 1987 Electronics revenue ($ millions)	Calendar year 1987 Total revenue ($ millions)	Calendar year 1987 Net income ($ millions)	Fiscal year 1987 Total revenue ($ millions)	Fiscal year 1987 Net income ($ millions)	Return on equity	Return on investment
151	164	Mentor Graphics	$221.8	$221.8	$20.3	$221.8	$20.3	10.8%	10.5%
152	144	Avantek	213.7	213.7	11.6	213.7	11.6	7.5%	7.5%
153	—	Cullinet Software	213.4	213.4	-30.6	174.9	-27.6	-23.2%	-20.3%
154	154	Micom Systems	211.5	211.5	9.3	196.7	12.2	7.1%	6.8%
155	145	Logicon	211.4	211.4	6.5	204.8	6.1	10.5%	10.5%
156	166	Veeco Instruments	211.1	211.1	9.8	195.6	9.2	9.2%	6.2%
157	143	Fluke	206.7	206.7	2.3	206.3	2.0	1.9%	1.7%
158	178	Applied Materials	202.3	202.3	7.5	174.4	0.3	0.2%	0.2%
159	172	Ultimate	201.1	201.1	17.4	172.9	13.8	15.5%	14.5%
160	176	Digital Communications	200.6	200.6	34.2	181.4	27.0	17.2%	17.2%
161	128	Cincinnati Milacron	200.0	828.0	-80.0	828.0	-80.0	-37.2%	-19.4%
162	198	Anthem Electronics	196.9	196.9	5.0	196.9	5.0	7.3%	6.7%
163	—	Imo Delaval	196.7	368.5	20.1	368.5	18.7	9.0%	4.0%
164	155	Bell & Howell	195.0	726.9	21.0	726.9	21.0	7.7%	4.6%
165	146	GenRad	193.8	193.8	2.1	193.8	2.1	2.9%	1.4%
166	156	General DataComm	192.6	192.6	-8.3	200.6	0.8	0.9%	0.7%
167	179	Esterline	192.0	270.4	-28.0	259.7	-29.3	-39.1%	-21.6%
168	183	Dynascan	191.6	191.6	6.6	191.6	6.6	14.5%	9.1%
169	150	Decision Industries [2]	191.4	191.4	-23.3	191.4	-20.4	-28.0%	-27.8%
170	199	Olin	190.0	1,930.0	78.0	1,930.0	78.0	11.1%	6.8%
171	—	Combustion Engineering	189.8	3,042.1	56.6	3,042.1	56.6	6.6%	4.6%
172	—	Oracle Systems	186.9	186.9	23.3	131.3	15.6	18.9%	16.1%
173	167	Ametek	185.0	620.1	41.2	620.1	41.2	16.3%	9.9%
174	—	Stratus Computer	184.2	184.2	19.4	184.2	19.4	18.9%	17.6%
175	169	Sun Electric [3]	181.6	181.6	2.6	203.9	3.3	4.1%	2.5%
176	173	ISC Systems	179.4	179.4	8.1	168.5	6.5	6.5%	5.4%
177	—	Quantum	178.3	178.3	8.1	120.8	8.8	8.1%	8.1%
178	186	ADC Telecommunications	177.7	177.7	17.4	166.9	15.3	20.1%	19.3%
179	189	Burndy	176.0	283.9	11.6	283.9	11.6	7.2%	5.3%
180	200	Thomas & Betts	175.0	436.5	48.5	436.5	48.5	16.8%	14.6%
181	—	Inmac	174.5	174.5	7.3	165.4	7.7	22.9%	20.0%
182	—	Oak Industries	173.1	182.2	5.7	182.2	5.7	7.2%	4.8%
183	160	Cipher Data Products	172.9	172.9	5.2	178.2	4.3	3.1%	3.1%
184	—	VLSI Technology	172.0	172.0	8.1	172.0	8.1	5.7%	3.9%
185	193	Coherent	171.5	171.5	0.7	159.0	-1.1	-1.3%	-1.0%
186	—	3Com	171.1	171.1	15.0	110.4	11.1	14.6%	14.5%
187	159	NBI	170.0	261.5	-17.9	278.3	5.9	6.5%	3.7%
188	192	Altos Computer Systems	168.3	168.3	14.4	153.9	9.7	9.1%	7.4%
189	187	Intelligent Systems	163.2	163.2	10.2	163.2	10.2	24.7%	16.4%
190	—	Cherry Electrical Products	160.7	187.4	5.6	160.6	2.7	4.4%	2.8%
191	—	Gencorp	158.6	1,619.0	18.0	1,619.0	18.0	-9.3%	5.8%
192	171	Tyco Laboratories	156.0	1,252.1	51.3	1,062.9	44.1	18.7%	11.7%
193	195	United Industrial	155.0	297.5	14.3	297.5	14.3	14.7%	9.8%
194	—	Brush Wellman	153.8	307.6	26.2	307.6	26.2	10.8%	8.9%
195	—	Insilco	153.2	639.7	33.9	639.7	33.9	11.3%	6.9%
196	190	Pittway	152.0	649.1	32.4	649.1	32.4	10.4%	8.5%
197	177	International Rectifier	151.0	151.0	-23.6	151.8	-17.2	-42.2%	-13.4%
198	—	LTX	149.6	149.6	1.6	120.6	-6.7	-12.7%	-9.9%
199	196	Aydin	149.2	149.2	14.8	149.2	8.8	12.6%	11.1%
200	—	Computer Consoles	148.4	148.4	9.6	148.4	9.6	29.9%	8.1%

[1] went private April 29, 1988

[2] calendar year 1987 includes only 11 months from Feb. to Dec. Changed fiscal year from Oct. to Dec.

NA = not available

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987: R&D as a percentage of revenue	Fiscal year 1987: Revenue per employee ($ thousands)	Fiscal year 1987: Net income per employee ($ thousands)	Five-year growth (Compounded average annual growth rate): Revenue	Five-year growth (Compounded average annual growth rate): Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
43.0%	10.9%	$184.9	$16.9	164.1%	NM	43.2%	3.0%	45.9%	12/87
55.9%	12.3%	70.3	3.8	20.6%	4.3%	97.7%	0.0%	13.0%	12/87
87.8%	28.5%	72.6	-11.5	28.8%	NM	-124.9%	12.3%	26.4%	4/87
44.9%	11.3%	96.3	6.0	27.8%	8.8%	45.7%	4.2%	10.0%	3/87
83.1%	0.8%	81.9	2.4	18.9%	14.4%	52.0%	0.0%	NA	3/87
54.3%	6.2%	67.4	3.2	11.3%	1.6%	68.6%	32.2%	46.1%	9/87
41.6%	10.8%	86.0	0.8	25.9%	-15.7%	66.9%	9.7%	40.5%	9/87
53.8%	17.9%	124.1	0.2	13.9%	NM	119.6%	14.4%	43.9%	10/87
49.7%	2.6%	384.1	30.6	42.1%	36.6%	37.8%	6.0%	23.4%	4/87
28.3%	11.6%	153.0	22.8	66.4%	107.7%	57.4%	0.0%	19.0%	6/87
74.9%	4.3%	89.5	-8.6	1.7%	NM	-23.3%	47.9%	19.8%	12/87
76.7%	0.0%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	NA	12/87
64.4%	2.0%	56.7	2.9	NA	NA	34.8%	55.4%	29.0%	12/87
59.8%	5.0%	81.3	2.4	3.5%	2.6%	86.9%	39.7%	31.1%	12/87
39.2%	13.6%	91.7	1.0	0.6%	-25.1%	66.0%	50.4%	40.4%	12/87
50.6%	12.6%	76.0	0.3	27.0%	NM	134.9%	21.2%	21.9%	9/87
63.5%	4.7%	82.3	-9.3	6.0%	NM	-14.5%	44.6%	39.1%	10/87
73.4%	0.8%	496.3	17.1	18.2%	14.2%	22.1%	37.2%	2.1%	12/87
74.7%	5.7%	123.9	-13.2	20.9%	NM	-31.9%	0.4%	5.5%	11/87
69.3%	3.2%	136.9	5.5	4.2%	14.9%	72.3%	38.7%	12.6%	12/87
82.0%	1.7%	110.3	2.1	5.1%	-10.5%	74.3%	30.1%	33.1%	12/87
61.7%	6.0%	117.1	13.9	NA	NA	80.6%	14.7%	46.8%	5/87
71.0%	3.7%	88.6	5.9	7.9%	8.6%	72.7%	39.1%	NA	12/87
31.7%	10.3%	150.4	15.8	101.8%	NM	49.6%	7.3%	29.2%	12/87
53.2%	2.4%	83.5	1.3	5.5%	NM	55.5%	37.2%	30.0%	10/87
54.4%	8.4%	94.3	3.7	22.1%	-4.2%	68.4%	17.0%	NA	6/87
61.4%	9.5%	173.5	12.7	54.6%	116.3%	42.6%	0.0%	21.0%	3/87
47.8%	9.3%	92.9	8.5	21.8%	26.9%	47.5%	4.3%	12.4%	10/87
60.6%	4.4%	69.9	2.9	4.6%	-5.4%	61.5%	25.4%	44.3%	12/87
45.8%	4.3%	103.9	11.5	9.6%	15.4%	96.8%	13.3%	41.5%	12/87
62.8%	0.0%	258.5	12.1	NA	NA	28.9%	12.9%	59.2%	7/87
77.7%	2.2%	47.4	1.5	-9.6%	NM	47.7%	34.1%	14.4%	12/87
67.9%	11.3%	94.7	2.3	25.0%	12.5%	55.5%	1.8%	18.4%	6/87
42.5%	17.8%	127.9	6.0	-23.5%	-20.2%	152.1%	32.5%	22.1%	12/87
58.8%	11.3%	98.3	-0.7	14.6%	9.5%	222.4%	20.8%	46.4%	9/87
46.2%	8.4%	200.0	20.2	NA	NA	43.7%	0.4%	24.0%	5/87
50.1%	3.5%	88.5	1.9	22.7%	-11.6%	31.3%	43.5%	NA	6/87
55.9%	9.0%	196.8	12.4	24.7%	11.1%	199.8%	19.3%	42.0%	6/87
61.6%	4.0%	333.1	20.8	46.0%	26.0%	17.1%	33.6%	26.6%	12/87
66.4%	6.0%	55.7	0.9	12.3%	-8.5%	114.5%	36.8%	49.4%	2/87
77.2%	2.2%	114.8	1.3	NA	NA	200.0%	162.6%	NA	11/87
74.9%	0.5%	100.3	4.2	0.1%	13.7%	68.0%	37.3%	8.8%	5/87
74.7%	0.0%	63.8	3.1	8.5%	4.4%	63.6%	33.0%	NA	12/87
63.5%	2.1%	120.0	10.2	14.4%	8.1%	58.3%	17.9%	26.2%	12/87
64.2%	0.6%	86.5	4.6	0.1%	5.7%	95.1%	38.6%	NA	12/87
59.1%	2.5%	81.1	4.0	9.8%	3.2%	77.2%	18.7%	19.4%	12/87
75.4%	5.3%	64.5	-7.3	11.9%	NM	-61.8%	68.2%	50.1%	6/87
45.8%	19.2%	103.7	-5.8	20.7%	NM	283.6%	21.6%	51.0%	7/87
65.1%	6.7%	74.6	4.4	3.7%	-3.1%	31.0%	12.6%	17.8%	12/87
33.9%	14.0%	114.9	7.4	13.4%	5.4%	22.1%	72.8%	21.4%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

ALPHABETICAL INDEX

COMPANY	RANK
ADC Telecommunications Inc.	178
AM International Inc.	103
AMP Inc.	34
AST Research Inc.	119
AT&T Co.	2
AVX Corp.	123
Advanced Micro Devices Inc.	57
Allied-Signal Inc.	18
Altos Computer Systems	188
Amdahl Corp.	41
Ametek Inc.	173
Analog Devices Inc.	97
Andrew Corp.	147
Anthem Electronics Inc.	162
Apollo Computer Inc.	78
Apple Computer Inc.	22
Applied Magnetics Corp.	144
Applied Materials Inc.	158
Arrow Electronics Inc.	77
Ashton-Tate Corp.	129
Atari Corp.	82
Augat Inc.	111
Avantek Inc.	152
Avnet Inc.	42
Aydin Corp.	199
Ball Corp.	141
Bally Manufacturing Corp.	137
Bell & Howell Co.	164
Bell Industries Inc.	140
Boeing Co., The	33
Bolt Beranek and Newman Inc.	122
BRIntec Corp.	150
Brush Wellman Inc.	194
Burndy Corp.	179
CTS Corp.	135
Cherry Electrical Products Corp.	190
Chrysler Corp.	59
Cincinnati Milacron Inc.	161
Cipher Data Products Inc.	183
Coherent Inc.	185
Combustion Engineering Inc.	171
Compaq Computer Corp.	47
Computer Associates International Inc.	74
Computer Consoles Inc.	200
Computervision Corp.	75
Contel Corp.	69
Control Data Corp.	26
Cooper Industries Inc.	139
Corning Glass Works	80
Cray Research Inc.	68
Cubic Corp.	114
Cullinet Software Inc.	153
DSC Communications Corp.	112
Data General Corp.	45
Datapoint Corp.	110
Dataproducts Corp.	107
Decision Industries Corp.	169
Diasonics Inc.	127
Diebold Inc.	101
Digital Communications Associates Inc.	160
Digital Equipment Corp.	4
Dover Corp.	100
Du Pont, E.I. de Nemours & Co.	32
Dynascan Corp.	168
Dynatech Corp.	102
E-Systems Inc.	54
EG&G Inc.	91
Eastman Kodak Co.	15
Eaton Corp.	64
Eli Lilly & Co.	115
Emerson Electric Co.	39
Emerson Radio Corp.	63
Emhart Corp.	96
Esterline Corp.	167
Figgie International Inc.	131
Fluke Manufacturing Co. Inc., John	157
Ford Motor Co.	24
Foxboro Co., The	128
GM Hughes Electronics Corp.	3
GTE Corp.	38
GenRad Inc.	165
Gencorp Inc.	191
General DataComm Industries Inc.	166
General Dynamics Corp.	55
General Electric Co.	6
General Instrument Corp.	50
General Signal Corp.	70
Genicom Corp.	116
Gerber Scientific Inc.	138
Gould Inc.	60
Grumman Corp.	51
Harris Corp.	30
Hewlett-Packard Co.	8
Honeywell Inc.	10
IBM Corp.	1
ISC Systems Corp.	176
ITT Corp.	27
Imo Delaval Inc.	163
Inmac Corp.	181
Insilco Corp.	195
Intel Corp.	35
Intelligent Systems Master L.P.	189
Intergraph Corp.	71
International Rectifier Corp.	197
Johnson Controls Inc.	62
Kollmorgen Corp.	136
LSI Logic Corp.	134
LTV Corp.	93
LTX Corp.	198
Litton Industries Inc.	20
Lockheed Corp.	13
Logicon Inc.	155
Loral Corp.	61
Lotus Development Corp.	94
M/A-COM Inc.	88
MAI Basic Four Inc.	106
Mark IV Industries Inc.	113
Marshall Industries	105
Martin Marietta Corp.	23
Maxtor Corp.	142
McDonnell Douglas Corp.	37
Measurex Corp.	149
Medtronic Inc.	79
Mentor Graphics Corp.	151
Micom Systems Inc.	154
Micropolis Corp.	121
Microsoft Corp.	86
MiniScribe Corp.	99
Minnesota Mining & Manufacturing Co.	25
Molex Inc.	90
Monsanto Co.	72
Motorola Inc.	9
NBI Inc.	187
NCR Corp.	11
Nashua Corp.	104
National Semiconductor Corp.	36
Northrop Corp.	49
Oak Industries Inc.	182
Olin Corp.	170
Oracle Systems Corp.	172
Paradyne Corp.	146
Penn Central Corp.	109
Perkin-Elmer Corp., The	46
Pioneer-Standard Electronics Inc.	143
Pitney Bowes Inc.	31
Pittway Corp.	196
Polaroid Corp.	108
Premier Industrial Corp.	117
Prime Computer Inc.	58
Quantum Corp.	177
Raychem Corp.	87
Raytheon Co.	14
Recognition Equipment Inc.	126
Reynolds & Reynolds Co.	145
Rockwell International Corp.	16
SCI Systems Inc.	73
Savin Corp.	130
Scientific-Atlanta Inc.	81
Seagate Technology	53
Singer Co., The	40
SmithKline Beckman Corp.	67
Sprague Technologies Inc.	89
Square D Co.	124
Storage Technology Corp.	66
Stratus Computer Inc.	174
Sun Electric Corp.	175
Sun Microsystems Inc.	65
Sundstrand Corp.	148
TIE/communications Inc.	125
TRW Inc.	19
Tandem Computers Inc.	52
Tandon Corp.	120
Tandy Corp.	17
Tektronix Inc.	44
Teledyne Inc.	48
Teradyne Inc.	98
Texas Instruments Inc.	12
Textron Inc.	92
Thomas & Betts Corp.	180
3Com Corp.	186
Tyco Laboratories Inc.	192
Tyler Corp.	84
Ultimate Corp., The	159
Unisys Corp.	5
United Industrial Corp.	193
United Technologies Corp.	43
United Telecommunications Inc.	83
VLSI Technology Inc.	184
Varian Associates Inc.	56
Veeco Instruments Inc.	156
Wang Laboratories Inc.	21
Watkins-Johnson Co.	133
Western Digital Corp.	76
Westinghouse Electric Corp.	28
Westmark International Inc.	118
Wyle Laboratories Inc.	132
Wyse Technology	95
Xerox Corp.	7
Xidex Corp.	85
Zenith Electronics Corp.	29

The Electronic Business 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
COMMUNICATIONS								
Dynascan	$496.3	3.4%	9.1%	73.4%	0.8%	0.9%	2.1%	168
3Com	200.0	10.1%	14.5%	46.2%	8.4%	5.7%	24.0%	186
TIE/communications	166.8	-4.4%	-5.1%	66.7%	8.6%	1.7%	30.3%	125
Digital Communications	153.0	14.9%	17.2%	28.3%	11.6%	10.5%	19.0%	160
Scientific-Atlanta	147.9	4.9%	11.6%	69.0%	4.1%	1.4%	15.0%	81
DSC Communications	122.8	4.7%	5.1%	49.6%	13.1%	7.4%	14.4%	112
Dynatech	98.3	7.6%	13.9%	40.8%	9.0%	4.1%	25.4%	102
Andrew	97.0	1.7%	2.2%	63.1%	4.7%	5.2%	40.7%	147
Micom Systems	96.3	6.2%	6.8%	44.9%	11.3%	4.6%	10.0%	154
ADC Telecommunications	92.9	9.1%	19.3%	47.8%	9.3%	6.7%	12.4%	178
Bolt Beranek and Newman	87.6	-3.4%	-8.7%	52.8%	6.1%	9.5%	0.0%	122
General DataComm Industries	76.0	0.4%	0.7%	50.6%	12.6%	7.6%	21.9%	166
Paradyne	74.7	-1.1%	-1.1%	53.0%	8.2%	5.2%	17.9%	146
Aydin	74.6	5.9%	11.1%	65.1%	6.7%	2.8%	17.8%	199
Avantek	70.3	5.4%	7.5%	55.9%	12.3%	11.4%	13.0%	152
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
M/A-COM	64.6	-6.7%	-7.5%	69.0%	5.6%	6.1%	21.5%	88
General Instrument	48.3	2.3%	2.8%	76.5%	3.1%	8.0%	16.2%	50
Weighted average	**$74.5**	**3.8%**	**6.1%**	**55.9%**	**7.5%**	**8.2%**	**33.1%**	
GOVERNMENT								
GM Hughes Electronics	$104.8	5.0%	6.7%	72.3%	4.0%	4.5%	11.6%	3
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Watkins-Johnson	84.4	6.5%	12.0%	58.7%	6.4%	4.7%	19.0%	133
SCI Systems	83.0	2.9%	5.0%	93.0%	0.0%	5.4%	24.8%	73
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Logicon	81.9	3.0%	10.5%	83.1%	0.8%	1.9%	0.0%	155
Litton Industries	81.5	3.1%	10.8%	76.1%	4.7%	5.5%	22.7%	20
Cubic	80.4	2.2%	4.1%	73.4%	1.4%	4.7%	0.0%	114
E-Systems	79.1	4.9%	11.8%	81.4%	2.7%	4.2%	6.6%	54
Aydin	74.6	5.9%	11.1%	65.1%	6.7%	2.8%	17.8%	199
Texas Instruments	71.7	4.6%	9.2%	71.5%	7.7%	8.3%	31.5%	12
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
Singer	68.0	1.2%	1.5%	92.2%	2.0%	4.1%	0.0%	40
Loral	47.6	8.3%	13.6%	73.9%	4.6%	5.0%	6.2%	61
Weighted average	**$81.3**	**4.2%**	**7.2%**	**68.8%**	**5.3%**	**5.9%**	**22.0%**	
DISTRIBUTORS								
Anthem Electronics	$447.5	2.5%	6.7%	76.7%	0.0%	0.5%	0.0%	162
Arrow Electronics	308.0	-2.8%	-10.0%	79.4%	0.0%	0.4%	0.0%	77
Marshall Industries	260.6	1.8%	5.1%	75.1%	0.0%	3.2%	0.0%	105
Pioneer-Standard Electronics	253.6	0.9%	2.2%	75.3%	0.0%	1.1%	0.0%	143
Wyle Laboratories	169.5	1.6%	4.3%	76.7%	0.0%	1.0%	0.0%	132
Avnet	162.8	1.5%	2.6%	73.5%	0.0%	3.1%	0.0%	42
Weighted average	**$199.9**	**0.8%**	**1.7%**	**75.4%**	**0.0%**	**2.1%**	**0.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
CAPITAL EQUIPMENT								
Gerber Scientific	$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	138
Applied Materials	124.1	0.2%	0.2%	53.8%	17.9%	6.6%	43.9%	158
LTX	103.7	-5.6%	-9.9%	45.8%	19.2%	11.3%	51.0%	198
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Perkin-Elmer	94.5	-1.4%	-2.0%	52.6%	10.5%	5.0%	46.2%	46
GenRad	91.7	1.1%	1.4%	39.2%	13.6%	6.0%	40.4%	165
John Fluke	86.0	1.0%	1.7%	41.6%	10.8%	4.0%	40.5%	157
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	175
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Esterline	82.3	-11.3%	-21.6%	63.5%	4.7%	1.0%	39.1%	167
Tektronix	81.6	3.7%	5.7%	39.8%	14.3%	2.9%	42.2%	44
Teradyne	80.4	-5.7%	-6.5%	50.2%	16.3%	10.8%	36.4%	98
Weighted average	**$94.0**	**4.9%**	**6.9%**	**45.8%**	**11.2%**	**5.6%**	**45.1%**	
OFFICE EQUIPMENT								
Savin	$176.4	0.0%	0.1%	57.8%	1.3%	0.3%	10.8%	130
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Datapoint	113.5	-18.7%	-20.1%	57.8%	6.2%	8.2%	79.2%	110
Xerox	104.2	5.6%	7.5%	45.1%	7.0%	9.1%	44.9%	7
Wang Laboratories	93.6	2.5%	3.1%	27.1%	7.5%	4.5%	40.1%	21
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Diebold	90.0	8.1%	10.3%	64.6%	3.3%	1.9%	7.0%	101
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Pitney Bowes	76.4	8.9%	13.5%	31.7%	2.9%	11.2%	19.5%	31
Weighted average	**$121.8**	**8.4%**	**11.1%**	**40.6%**	**8.9%**	**7.8%**	**50.0%**	
COMPUTER-BASED SYSTEMS								
Gerber Scientific	$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	138
Intergraph	101.8	10.9%	12.2%	45.1%	10.5%	6.8%	36.9%	71
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Coherent	98.3	-0.7%	-1.0%	58.8%	11.3%	5.3%	46.4%	185
ISC Systems	94.3	3.9%	5.4%	54.4%	8.4%	5.2%	0.0%	176
Recognition Equipment	90.7	4.2%	5.6%	53.5%	4.4%	8.2%	49.1%	126
Measurex	89.5	11.8%	15.2%	52.9%	7.3%	3.0%	59.4%	149
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	175
Weighted average	**$92.4**	**6.2%**	**9.2%**	**53.1%**	**8.0%**	**5.5%**	**36.5%**	
MEDICAL								
Diasonics	$177.2	5.7%	12.1%	58.4%	6.9%	3.0%	3.1%	127
Medtronic	101.4	14.7%	17.4%	28.4%	8.4%	5.7%	41.5%	79
Westmark International	96.6	-2.5%	-3.1%	55.6%	9.6%	3.6%	28.0%	118
Weighted average	**$111.9**	**7.7%**	**10.4%**	**43.5%**	**8.3%**	**4.4%**	**28.1%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
SEMICONDUCTORS								
Western Digital	$138.5	9.3%	20.3%	59.3%	8.1%	8.8%	36.9%	76
VLSI Technology	127.9	4.7%	3.9%	42.5%	17.8%	29.1%	22.1%	184
LSI Logic	113.0	4.1%	2.2%	48.7%	11.0%	66.6%	14.6%	134
Intel	99.3	9.2%	8.5%	45.7%	13.6%	15.8%	38.8%	35
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Texas Instruments	71.7	4.6%	9.2%	71.5%	7.7%	8.3%	31.5%	12
Analog Devices	71.2	5.0%	5.6%	37.3%	15.1%	11.6%	46.4%	97
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
International Rectifier	64.5	-11.3%	-13.4%	75.4%	5.3%	4.0%	50.1%	197
National Semiconductor	64.0	-1.5%	-2.9%	62.1%	11.7%	5.1%	42.1%	36
Advanced Micro Devices	55.3	-4.8%	-6.0%	41.1%	24.9%	13.8%	27.2%	57
Weighted average	**$73.9**	**3.9%**	**6.1%**	**57.8%**	**9.5%**	**9.8%**	**35.6%**	
COMPONENTS (other than semiconductors)								
AMP	$105.4	10.8%	6.3%	56.8%	8.8%	7.4%	52.3%	34
Augat	82.4	3.7%	4.8%	68.1%	5.1%	9.4%	18.0%	111
Molex	77.9	11.2%	13.3%	46.2%	5.5%	12.8%	68.4%	90
BRIntec	75.1	2.0%	4.0%	76.1%	1.5%	3.2%	15.8%	150
Cherry Electrical Products	55.7	1.7%	2.8%	66.4%	6.0%	9.6%	49.4%	190
Sprague Technologies	50.8	0.8%	1.0%	74.1%	4.8%	5.6%	38.2%	89
Oak Industries	47.4	3.1%	4.8%	77.7%	2.2%	3.4%	14.4%	182
CTS	39.3	4.0%	6.3%	75.5%	2.0%	5.1%	19.7%	135
AVX	36.3	5.8%	4.8%	66.0%	3.1%	11.7%	43.0%	123
Weighted average	**$72.1**	**7.5%**	**10.5%**	**62.3%**	**5.4%**	**7.6%**	**43.7%**	
PERIPHERALS								
Intelligent Systems	$333.1	6.2%	16.4%	61.6%	4.0%	1.7%	26.6%	189
Quantum	173.5	7.3%	8.1%	61.4%	9.5%	4.9%	21.0%	177
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	119
Wyse Technology	128.7	7.0%	18.2%	66.4%	5.3%	3.1%	20.2%	95
Decision Industries	123.9	-10.7%	-27.8%	74.7%	5.7%	2.6%	5.5%	169
Micropolis	120.9	9.4%	12.7%	72.7%	7.5%	7.7%	69.7%	121
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
Cipher Data Products	94.7	2.4%	3.1%	67.9%	11.3%	3.3%	18.4%	183
Maxtor	90.9	12.8%	10.7%	61.9%	6.7%	9.9%	16.0%	142
Dataproducts	86.9	2.6%	3.3%	64.5%	6.6%	3.2%	26.8%	107
Storage Technology	84.6	2.5%	3.1%	59.5%	8.0%	23.9%	0.0%	66
Genicom	84.2	4.2%	7.5%	64.8%	4.9%	3.1%	32.0%	116
Xidex	83.0	-7.8%	-8.4%	76.7%	2.0%	0.4%	29.9%	85
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	120
MiniScribe	72.9	7.8%	14.0%	71.3%	5.5%	13.9%	36.1%	99
Seagate Technology	59.9	14.6%	21.3%	68.6%	3.5%	8.2%	43.6%	53
Applied Magnetics	30.5	6.7%	9.2%	64.9%	9.2%	12.1%	46.5%	144
Weighted average	**$86.1**	**3.5%**	**5.8%**	**65.6%**	**7.9%**	**7.1%**	**26.7%**	

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THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
MAINFRAMES								
Amdahl	$198.0	9.4%	15.4%	47.8%	11.9%	10.5%	44.3%	41
Cray Research	159.5	21.4%	20.2%	11.4%	15.8%	5.8%	37.0%	68
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Unisys	105.0	6.0%	8.7%	32.5%	6.1%	7.4%	43.6%	5
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Weighted average	**$127.3**	**8.7%**	**11.8%**	**39.8%**	**9.4%**	**7.7%**	**50.8%**	
MINICOMPUTERS								
Stratus Computer	$150.4	10.5%	17.6%	31.7%	10.3%	7.5%	29.2%	174
Tandem Computers	147.8	10.2%	14.4%	29.6%	10.5%	13.7%	44.4%	52
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Apollo Computer	138.4	3.9%	6.3%	44.5%	11.0%	9.7%	51.8%	78
Sun Microsystems	128.5	6.8%	9.0%	46.1%	12.9%	14.2%	32.0%	65
Computer Consoles	114.9	6.5%	8.1%	33.9%	14.0%	3.3%	21.4%	200
Prime Computer	109.0	6.7%	6.1%	38.2%	11.4%	10.5%	48.0%	58
MAI Basic Four	98.7	7.1%	17.6%	44.6%	4.0%	4.1%	64.1%	106
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Digital Equipment	85.0	12.1%	17.3%	22.3%	10.8%	8.0%	47.0%	4
Data General	81.2	-6.5%	-11.7%	47.8%	12.5%	11.2%	45.0%	45
Weighted average	**$121.8**	**9.4%**	**11.9%**	**37.5%**	**10.3%**	**7.9%**	**51.9%**	
MICROCOMPUTERS								
Apple Computer	$475.2	8.2%	26.0%	46.1%	7.2%	3.2%	27.1%	22
Compaq Computer	306.0	11.1%	24.8%	56.8%	3.8%	9.3%	26.0%	47
Altos Computer Systems	196.8	6.3%	7.4%	55.9%	9.0%	18.8%	42.0%	188
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	119
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Atari	120.6	9.0%	14.2%	60.8%	3.7%	0.8%	45.9%	82
Tandy	88.5	7.0%	15.3%	47.4%	0.0%	2.7%	1.6%	17
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	120
Zenith Electronics	67.5	-0.8%	-2.1%	83.7%	4.4%	2.3%	17.2%	29
Weighted average	**$134.8**	**9.1%**	**12.3%**	**42.0%**	**9.0%**	**7.2%**	**48.2%**	
SOFTWARE								
Ultimate	$384.1	8.0%	14.5%	49.7%	2.6%	4.6%	23.4%	159
Ashton-Tate	213.9	16.1%	23.0%	11.6%	10.5%	2.4%	30.3%	129
Microsoft	190.5	20.8%	29.2%	19.2%	11.0%	16.8%	42.3%	86
Lotus Development	138.4	18.2%	30.0%	13.4%	14.8%	6.7%	52.3%	94
Mentor Graphics	184.9	9.2%	10.5%	43.0%	10.9%	6.6%	45.9%	151
Oracle Systems	117.1	11.9%	16.1%	61.7%	6.0%	12.9%	46.8%	172
Computer Associates International	114.6	11.8%	11.1%	-8.8%	13.0%	3.4%	48.7%	74
Cullinet Software	72.6	-15.8%	-20.3%	87.8%	28.5%	6.3%	26.4%	153
Weighted average	**$154.8**	**12.2%**	**16.1%**	**26.7%**	**12.4%**	**7.5%**	**41.3%**	

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The Electronic Business 200

BEST AND WORST PERFORMERS

NET INCOME/REVENUE

(percentage)

TOP 10		200 rank
Cray Research	21.4%	68
Microsoft	20.8%	86
Lotus Development	18.2%	94
Ashton-Tate	16.1%	129
Digital Communications	14.9%	160
Medtronic	14.7%	79
Seagate Technology	14.6%	53
SmithKline Beckman	13.2%	67
Maxtor	12.8%	142
Digital Equipment	12.1%	4
MEDIAN	4.7%	
BOTTOM 5		
Esterline	-11.3%	167
International Rectifier	-11.3%	197
Cullinet Software	-15.8%	153
Datapoint	-18.7%	110
Foxboro	-19.2%	128

R&D/REVENUE

(percentage)

TOP 10		200 rank
Cullinet Software	28.5%	153
Advanced Micro Devices	24.9%	57
LTX	19.2%	198
Applied Materials	17.9%	158
VLSI Technology	17.8%	184
Teradyne	16.3%	98
Cray Research	15.8%	68
Analog Devices	15.1%	97
Lotus Development	14.8%	94
Tektronix	14.3%	44
MEDIAN	5.5%	

For those 183 companies that reported research & development expenditures

RETURN ON EQUITY

(percentage)

TOP 10		200 rank
Seagate Technology	39.5%	53
SmithKline Beckman	36.0%	67
Lotus Development	35.7%	94
Compaq Computer	34.1%	47
Microsoft	30.1%	86
Computer Consoles	29.9%	200
MAI Basic Four	29.3%	106
MiniScribe	27.8%	99
Emerson Radio	27.7%	63
General Dynamics	27.3%	55
MEDIAN	11.1%	
BOTTOM 5		
Datapoint	-32.2%	110
Cincinnati Milacron	-37.2%	161
Esterline	-39.1%	167
International Rectifier	-42.2%	197
Foxboro	-51.5%	128

RETURN ON INVESTMENT

(percentage)

TOP 10		200 rank
Lotus Development	30.0%	94
Microsoft	29.2%	86
Apple Computer	26.0%	22
Compaq Computer	24.8%	47
Ashton-Tate	23.0%	129
General Dynamics	21.6%	55
Seagate Technology	21.3%	53
Ford Motor	21.0%	24
SmithKline Beckman	20.4%	67
Western Digital	20.3%	76
MEDIAN	7.5%	
BOTTOM 5		
Cullinet Software	-20.3%	153
Esterline	-21.6%	167
LTV	-25.0%	93
Decision Industries	-27.8%	169
Foxboro	-40.1%	128

REVENUE PER EMPLOYEE

($ thousands)

TOP 10		200 rank
Emerson Radio	$1,012.6	63
Dynascan	496.3	168
Apple Computer	475.2	22
Anthem Electronics	447.5	162
Ultimate	384.1	159
Intelligent Systems	333.1	189
Arrow Electronics	308.0	77
Compaq Computer	306.0	47
Marshall Industries	260.6	105
Inmac	258.5	181
MEDIAN	$96.3	
BOTTOM 5		
Loral	$47.6	61
Oak Industries	47.4	182
CTS	39.3	135
AVX	36.3	123
Applied Magnetics	30.5	144

NET INCOME PER EMPLOYEE

($ thousands)

TOP 10		200 rank
Microsoft	$39.6	86
Apple Computer	38.8	22
Ashton-Tate	34.5	129
Lotus Development	34.3	94
Cray Research	34.1	68
Compaq Computer	34.1	47
Emerson Radio	33.3	63
Ultimate	30.6	159
Tyler	30.3	84
Digital Communications	22.8	160
MEDIAN	$4.2	
BOTTOM 5		
Esterline	-$9.3	167
Cullinet Software	-11.5	153
Decision Industries	-13.2	169
Foxboro	-13.8	128
Datapoint	-21.3	110

FIVE-YEAR REVENUE GROWTH

(compounded average annual growth rate)

TOP 10		200 rank
Sun Microsystems	474.4%	65
Lotus Development	356.3%	94
AST Research	249.5%	119
Mentor Graphics	164.1%	151
MiniScribe	135.5%	99
LSI Logic	120.8%	134
Wyse Technology	102.7%	95
Stratus Computer	101.8%	174
Apollo Computer	98.2%	78
Seagate Technology	88.3%	53
MEDIAN	11.3%	
BOTTOM 5		
Datapoint	-9.3%	110
Oak Industries	-9.6%	182
ITT	-11.7%	27
Penn Central	-14.8%	109
VLSI Technology	-23.5%	184

FIVE-YEAR NET INCOME GROWTH

(compounded average annual growth rate)

TOP 10		200 rank
Micropolis	206.9%	121
Emerson Radio	145.2%	63
Apollo Computer	135.4%	78
Quantum	116.3%	177
Digital Communications	107.7%	160
Amdahl	96.1%	41
Microsoft	83.0%	86
Seagate Technology	82.5%	53
Northrop	79.9%	49
Ashton-Tate	74.0%	129
MEDIAN	9.2%	
BOTTOM 5		
Penn Central	-23.3%	109
GenRad	-25.1%	165
General Instrument	-28.1%	50
Control Data	-30.6%	26
Kollmorgen	-50.6%	136

FOREIGN REVENUE/TOTAL REVENUE

(percentage of total revenue)

TOP 10		200 rank
Datapoint	79.2%	110
Tandon	75.0%	120
Micropolis	69.7%	121
Molex	68.4%	90
MAI Basic Four	64.1%	106
Raychem	61.6%	87
Measurex	59.4%	149
Inmac	59.2%	181
NCR	54.6%	11
IBM	54.0%	1
MEDIAN	28.5%	
BOTTOM 5		
Loral	6.2%	61
Decision Industries	5.5%	169
Diasonics	3.1%	127
Dynascan	2.1%	168
Tandy	1.6%	17

CAPITAL EXPENDITURES

(percentage of net cash flow after dividends)

TOP 10		200 rank
Data General	576.1%	45
Perkin-Elmer	492.2%	46
Bolt Beranek and Newman	489.1%	122
Teradyne	374.1%	98
Westmark International	366.7%	118
LSI Logic	339.5%	134
LTX	283.6%	198
Zenith Electronics	247.3%	29
Coherent	222.4%	185
United Telecommunications	218.9%	83
MEDIAN	65.0%	
BOTTOM 5		
Datapoint	-74.1%	110
Cullinet Software	-124.9%	153
Xidex	-150.0%	85
TIE/communications	-187.6%	125
M/A-COM	-295.1%	88

THE 200: ARRIVALS AND DEPARTURES

ARRIVALS	1987 rank
Computer Associates	74
Raychem	87
Sprague Technologies	89
MAI Basic Four	106
Westmark International	118
Cullinet Software	153
Imo Delaval	163
Combustion Engineering	171
Oracle Systems	172
Stratus Computer	174
Quantum	177
Inmac	181
Oak Industries	182
VLSI Technology	184
3Com	186
Cherry Electrical	190
Gencorp	191
Brush Wellman	194
Insilco	195
LTX	198
Computer Consoles	200

DEPARTURES	1986 rank
ADT[1]	163
Allen Group	165
Analogic	170
Becton, Dickinson	181
Compugraphic[2]	92
Convergent Technologies	101
Data Card[3]	175
Ducommun[4]	87
Electrospace Systems[5]	161
Fairchild Industries	197
Kidde[6]	162
Mark Controls	185
Monolithic Memories[7]	140
North American Philips[8]	18
Spectra-Physics[9]	142
Sun Chemical[10]	191
Telex[11]	62
Tracor[12]	76
UCCEL[13]	188
Union Carbide	122
Unitrode	182

[1] acquired by Hawley Group Ltd. Oct. 5, 1987

[2] as of Jan. 2, 1988, approximately 83.6% of Compugraphic's stock was owned by Agfa-Gevaert N.V. of Belgium

[3] acquired by Seedham Inc. Sept. 4, 1987

[4] sold its electronics distribution businesses to Arrow Electronics Inc. Jan. 12, 1988

[5] acquired by Chrysler Corp. Aug. 21, 1987

[6] acquired by Hanson Trust Plc Jan. 5, 1988

[7] acquired by Advanced Micro Devices Aug. 12, 1987

[8] owned by N.V. Philips

[9] acquired by Ciba-Geigy Ltd.

[10] changed name to Sequa Corp.

[11] acquired by Memorex International N.V. Jan. 28, 1988

[12] acquired by Westmark Systems Inc. (privately held) Dec. 22, 1987

[13] acquired by Computer Associates International Inc. Aug. 20, 1987

Oh, what a beautiful fiscal year it was!

This calendar year should be a lot better. The next fiscal, a little more beautiful. No clouds will gather before 1990

For leading companies such as Avnet, Digital Equipment, SCI Systems, Seagate Technology, Tandy and Wang — all of them members of the ELECTRONIC BUSINESS 200 — fiscal year 1988 may have turned out to be their best year ever.

So it seems, judging by the indices for revenue and profits from a sample of companies that we deem representative of the industry. According to the forecast by Cahners Economics, the revenue index for fiscal 1988 will be ahead by 13% over the previous fiscal year, while profits are expected to have climbed by a whopping 43%. Six months from now, when the year ends with the calendar, their composite results may show 15% growth in revenue and a still respectable but more sedate 10% in profits.

A large portion of the growth in revenue and profits for the past 12 months came from the semiconductor manufacturers which were coming out of the 1985-1986 slump. Intel almost quadrupled its profits in the first calendar quarter, compared with 1987's, on a 61% jump in revenue. A more modest, 26% growth in revenue by Motorola doubled the company's profits. The good news for chip makers is also heralding a slowing in their pace of growth. But, for the rest of the industry, the chip makers' bonanza is very good news indeed: since components lead the electronics market, it's now the other companies' turn to grow fast. This may mean that growth in the fiscal year 1989 will come from makers of computers and communications systems.

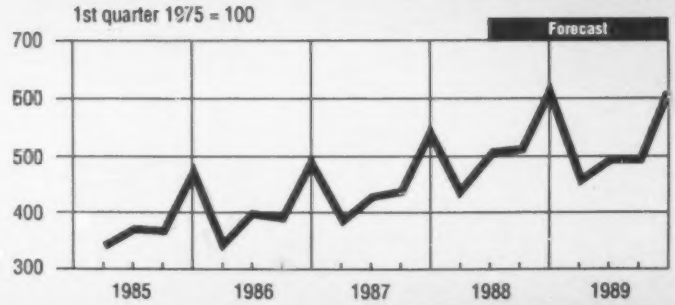
The ELECTRONIC BUSINESS leading indicator, which appears in the first issue of every month, provides a clue to the duration of this growth. Our indicator peaked last October at 120.3, indicating that the three-month period that ended in October 1987 was 20.3% higher than for the previous three months. According to Cahners' senior economist Elizabeth Baatz, it is expected to bottom out more than two years later. The emphasis here is on "leading." Our indicator leads U.S. semiconductor sales by up to nine months. That is, if the growth in chip sales has not slowed down yet, it is about to do so. The emphasis here is on "growth," because the indicator measures a rate of change. When it started going down last November, it signaled that growth in semi shipments will start to diminish about nine months later, not that sales will decline.

The rest of the electronics industry lags chip sales. Next are the makers of printed circuit board assembly equipment. Computer shipments follow, once the chips and the boards computer makers bought are assembled. So Apple's and IBM's sales will grow fast in the rest of this year: their growth may peak in the last calendar quarter and then go on at a slower pace for another year.

Last in the cycle are the manufacturers of capital equipment for the semiconductor industry. Chip makers have now used the huge overcapacity they had at the end of the recession in 1986. Capital equipment makers are now beginning to enjoy the good business their customers have had for over a year, and can look forward to brisk growth in revenue for the next 12 months. By then, says Baatz, our leading indicator will cross the 100 line, signaling that semiconductor shipments for the first quarter of 1990 may not grow with respect to the last quarter of 1989. But, even then, computer makers will still be doing well; capital equipment companies even better.

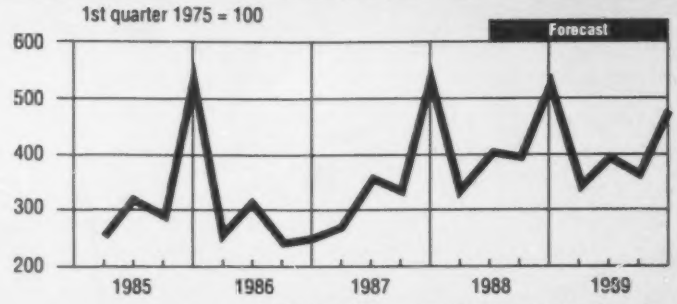
ALBERTO SOCOLOVSKY

ELECTRONIC BUSINESS revenue index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

ELECTRONIC BUSINESS profits index

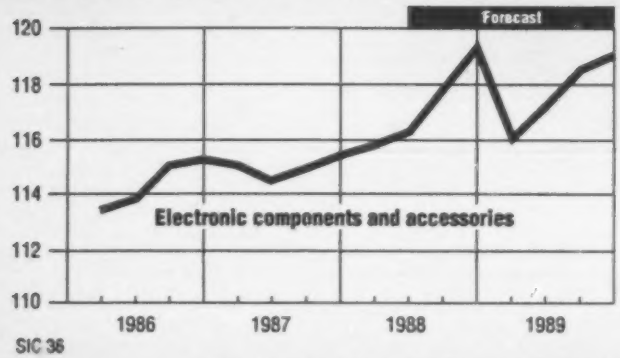


Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

PPI passive components — July 15

Producer price index — Electronic components

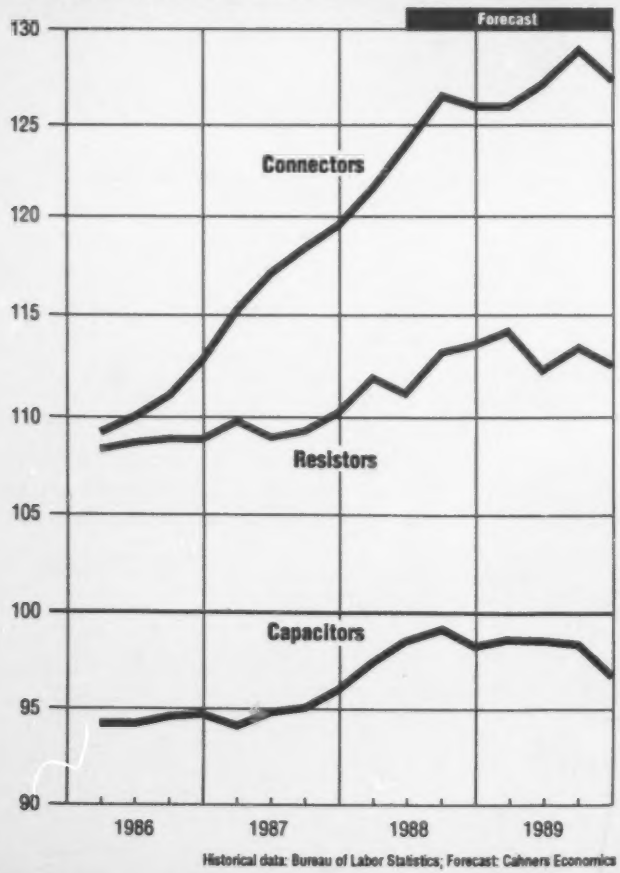
Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Passive components

Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Abundant supplies cap prices for passives

While DRAMS and 1Mb memory devices may be in short supply, abundant supplies of passive devices are holding passive prices down. After rising only 0.5% in 1987, producer prices of all electronic components appear headed for just a 2% price increase in 1988.

According to the U.S. Bureau of Labor Statistics, producer prices of capacitors jumped 3.7% in the first quarter of 1988, compared with a year ago. This was the largest quarterly price increase in several years. Part of the increase, however, is due to the low level of prices in the first quarter of 1987. Prices then were at their lowest in many years, following price declines in 1985 and 1986.

Leadtimes for capacitors stood at 7.5 weeks in June 1988, up from 5 weeks a year earlier. This lengthening in delivery times means producers of capacitors will have some leeway to increase their prices. The high percentage of capacitors which are sourced abroad is also fueling the 1988 price rise. Rising values of foreign currency as the U.S. dollar depreciates means foreign import prices have risen.

Price increases for resistors, which were weak in the middle of 1987, are back on the fast track in 1988. A 1.8% first quarter upturn in resistor producer prices presages somewhat higher price increases later in 1988.

Still, leadtimes for resistors have barely budged from June 1987 to June 1988, remaining around the five-week range. Stable leadtimes suggest supply and demand for resistors are fairly in balance. So the upward pressure on resistor prices may not be long-lived, particularly in 1989.

Connector prices, which rose 6.3% in 1987, jumped 5.4% in the first quarter of 1988. According the Labor Department surveys, connector prices have seen the fastest price increases of the passive components tracked here each month. Connector leadtimes, which stood at 6.8 weeks in June of 1987, inched up to 7.3 weeks this past June. Still three weeks below its 1984 peak, delivery times for connectors indicate few supply imbalances.

Of course, a fast delivery time for the passive components and reasonable price increases mean nothing to the computer manufacturer if the crucial memory devices are in short supply, causing prices to double. But for practical management purposes, at least you can ignore the passive price forecast while you concentrate on tracking down DRAMs.

Full-fledged recovery

Computer and office machinery makers are in full-fledged recovery right now. First-quarter new orders totaled $16.6 billion, a 26% increase compared with the same quarter last year. Shipments have picked up the tempo too, surging 24% in the first quarter from a year ago. With computers and peripherals still on top of the shopping lists of many businesses, the buying spree isn't over yet.

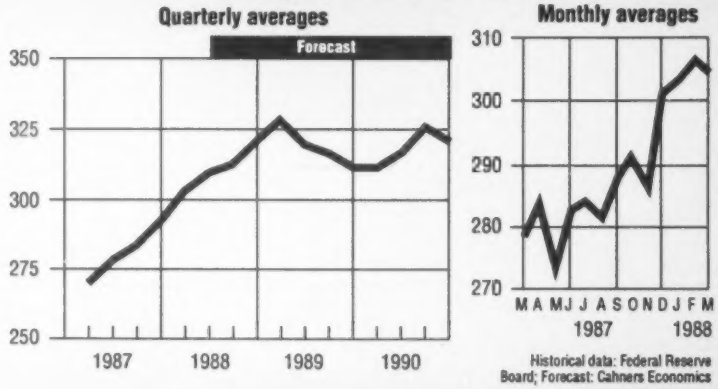
Growth in new orders and shipments will increase at an accelerating rate through the rest of this year. In 1989 and 1990, the slowdown in the U.S. economy and durable equipment investment will negatively affect the computer and office machinery industry.

However, this slump will be shorter and milder compared with the 1985-1986 plunge. Because inventory has been cautiously managed, excessive buildup will not be squeezing off production. Furthermore, with the dollar value low, exports will help stabilize sales.

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, MA 02158. Phone: (617) 964-3030.

Computers and office machinery — Industrial production

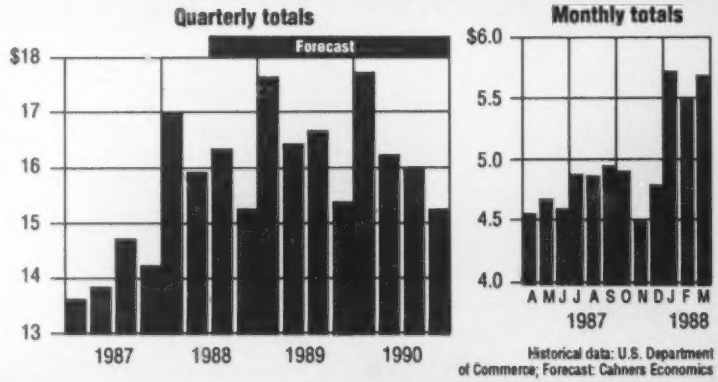
Seasonally adjusted index, 1977 = 100



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Computers and office machinery — Shipments

Seasonally adjusted ($ billions)



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, March)	305.4	307.1	-0.55%	278.8	+9.54%	330.0	+8.06%
Shipments (SA, $ millions, March)	$5,708	$5,531	+3.20%	$4,553	+25.37%	$5,884.0	+3.08%
New orders (SA, $ millions, March)	$5,288	$5,347	-1.10%	$4,686	+12.85%	$5,744	+8.62%
Unfilled orders (SA, $ millions, March)	$18,475	$18,895	-2.22%	$18,763	-1.53%	$19,193	+3.88%
Inventory-to-shipment ratio (SA, March)	1.79	1.83	—	2.12	—	1.84	—
All employees (thousands, March)	470.9	470.3	+0.13%	455.7	+3.34%	492.4	+4.57%
Production workers (thousands, March)	153.4	152.4	+0.66%	147.7	+3.86	156.2	+1.79%
Exports ($ millions, February)	$1,733	$1,719	+0.82%	$1,385	+25.11%	$1,872	+8.00%
Imports ($ millions, February)	$1,849	$1,616	+14.46%	$1,368	+35.23%	$1,869	+1.10%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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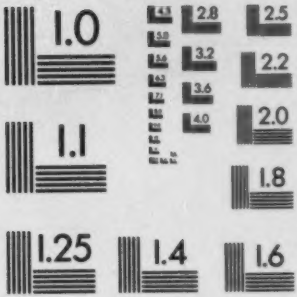
(ANSI and ISO TEST CHART No. 2)



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FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 1, 1988

MADE IN AMERICA

A computer company makes a turnaround in manufacturing PAGE 28

Booz, Allen: On distribution PAGE 86

RISC plus Unix equals HP's Spectrum PAGE 46

William Conlin
president of
CalComp

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 15 AUGUST 1, 1988

PAGE 28 CalComp's turnaround man Bill Conlin

COVER STORY/STRATEGIES

GRAPHICS PERIPHERALS

28 Made in America: CalComp plots a world-class future

CalComp's apparent success in the peripherals market suggests there may be hope for other U.S. manufacturers who would rather invest domestically than emigrate to cheap labor markets in the Far East.

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Now that NASA has wheeled the Space Shuttle program out of its hangar, many U.S. electronics manufacturers are ready to jump on board.

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Chip makers like Intel and Toshiba are backing a new programmable chip that could yield sales of over $800 million by 1992.

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ISDN has the potential to wipe modem makers off the map. But terminal adaptors could help keep them alive.

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24 Defense Dept. disgrace prompts reform—finally

The humiliation of the Pentagon payoffs scandal may do what the Packard panel couldn't: Change the system.

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GRAPHICS PERIPHERALS

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The Lockheed subsidiary is a textbook example of how one U.S. company turned around its fortunes through manufacturing in the United States.

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Hewlett-Packard bet early on RISC and Unix for its Spectrum computers. Those bets are now paying off, as HP challenges both IBM and DEC.

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While Britton Lee convalesces, Teradata glows with good health. In both cases, marketing made the difference.

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It's been a banner year for U.S. manufacturers abroad, thanks in part to the dramatically lower dollar and a new generation of computer gear.

Cover photo: Dave Bradley

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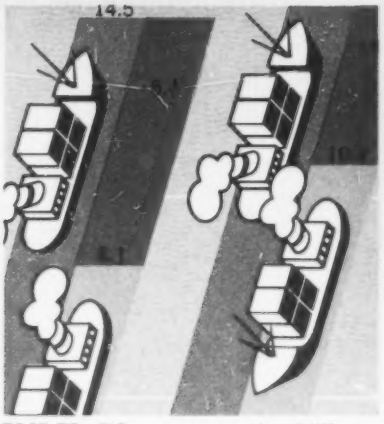
PAGE 75 Far East lessons from Ampex Ferrotec's S. K. Lau



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Called RAMP, the South Carolina-based experiment is already eliciting keen interest from IBM and other prime contractors.

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When Honda, Nissan and the rest set up U.S. assembly plants, American electronics suppliers got excited. They needn't expect to get rich quick.

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Made in America

Ostensibly, the cover story of this edition is about CalComp, the plotter and digitizer division of Lockheed Corp., which claims to be in the forefront of just-in-time, statistical quality control and other advanced manufacturing techniques. We'd like to think, though, that there's more to this article than just a simple corporate profile. The story of CalComp is really the tale of how one American company has rejuvenated its revenue and profits in a price-sensitive market through a solid top-down commitment to manufacturing at home.

Faced with a tough choice between the United States and Singapore, Bill Conlin, CalComp's president, chose the United States as his manufacturing base. And so far, he has no apparent reason to regret that decision. Associate editor Bruce Rayner talked to Conlin and a half-dozen other executives at CalComp to get the story. We think it makes fascinating reading.

Beth Karlin and George Koopman, president of Amroc

More on manufacturing

In addition to our profile of CalComp, we're also taking a look at manufacturing in the auto industry. In this third article in a series on automotive electronics, contributing editor Norm Alster talks to Honda, Nissan and other Japanese car firms that have set up manufacturing plants in the United States.

Do these Japanese transplants plan on buying more of their electronic subsystems from U.S. companies now that they're incorporated in America? Not necessarily, experts say. The carmakers will source metal stampings and other less sophisticated parts in the United States, but the electronics side of the business still belongs largely to Japanese subcontractors. As Robert Drave, Nissan's vice president for engineering and purchasing, points out: "We find in most cases that the Japanese quality is better."

Born to move

We'd also like to call your attention to Beth Karlin's overview of the space electronics market in our "Business Trends" section. To complete her assignment, Beth traveled to Edwards Air Force Base in the middle of California's Mojave Desert to interview George Koopman, president of American Rocket.

Incidentally, Beth, who has worked for us for several years — first in London and then in Washington, D.C. — recently moved to Boston to join us as assistant managing editor. In her new position, Beth will oversee ELECTRONIC BUSINESS magazine's far-reaching network of contributing editors in the United States and Europe. Welcome aboard, Beth.

AL FURST, editor

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BPA ABP

Think OSI — not just MAP

I read with interest your article on MAP in the May 1 issue. The coverage of MAP was good and timely but I believe there are some broader issues concerning the general Open Systems Interconnection (OSI) marketplace (which includes MAP and TOP) which would interest your readers. Those issues are: the Japanese response to OSI; the large vendor/small vendor conflict over standards; and the availability of OSI in silicon.

TONY HELIES
President
Concord Communications
Marlboro, Mass.

Editor's note: We plan to cover broader OSI perspectives in coming issues.

Carl Icahn, we need you

Your May 1, 1988 issue's cover story on Sematech was great, but it seems to miss the point and makes quite a few invalid assumptions.

Sematech is a $250 million boondoggle, half paid directly from government funds and the balance from corporate tax write-offs. Its purpose is to give a much needed boost to the Texas economy and to lock the Defense Department into dealing exclusively with American electronics manufacturers, thereby heading off DOD's recent forays into increased foreign purchases.

It is very doubtful that any big corporate or government bureaucracy can ever be innovative. Certainly, the 14 Sematech members have been about as innovative in the past 10 years as a bunch of angleworms. The simple fact is that the Japanese have become competitive by taking American technology and by investing in larger wafers, while these American dodos have sat, fat and happy on their hands, with smaller wafers and 64K and 256K DRAM products.

The "chip" industry has gotten into its current mess for the same reasons that put our once-great automobile industry into the morgue. Overpaid executives have been taking money under false pretenses, adding nothing but "cost" and "overhead" to their employer company's operation. At the same time, they have been cutting their future life's blood: R&D maintenance and capital expenditures for equipment and innovative products. "Three years, up or out" has been their motto.

Their love affair with counterproductive "offshore" vacations and its production rationalization has exacerbated the problem. Now, like the auto industry, these high-priced "bean counters" are turning to the American taxpayer to bail them out of their self-created mess. We, the American worker and taxpayer, will, of course, pick up the tab. Sematech will end up being the OPEC of the semiconductor business — another price-fixing cartel: zapping the American consumer and economy again. Carl Icahn and T. Boon Pickens, where are you when the electronics business and your country need you?

DANIEL B. McDEVITT
President
Research and Development
Institute of the U.S.
Tulsa, Okla.

Our side of the story

Your article, "Chip-making software: Still waiting for the big time" [May 15, 1988 p104] disturbs me because of inaccuracies about our company and its bias toward our primary competitor. We (Promis Systems Corp.), for example, are based in Toronto, not California. Furthermore, the story incorrectly gives the impression that Consilium's customer base is triple that of Promis and that we are out of step with the industry. That impression is clearly inaccurate.

We were not given the opportunity to verify data about the industry and our company, or be quoted in the story. That courtesy, however, was extended to our competitor.

DOUGLAS H. MEALY
Manager, Marketing Communications
Promis Systems Corp.
Santa Clara, Calif.

Corrections

I believe that you inadvertantly left our company, Data Switch Corporation, off your May 1, 1988, list of "1987's Fastest Growing Companies." We have grown from $18.183 million in revenue in 1982 to $96.886 million in 1987 (fiscal year ended Dec. 31, 1987). This growth is approximately 39.7% compounded per year . . . all in the electronics business. This would place us at number 35 on your list and third on your "Communications" segment behind DCA and Regency Electronics.

ROBERT G. GILBERTSON
President and CEO
Data Switch Corp.
Shelton, Conn.

In the July 15 issue's list of the top 200 electronics companies, Convergent Inc. [formerly Convergent Technologies Inc.] was omitted. Convergent, with 1987 sales of $384.8 million would have placed 98th on the list.

Also, the following companies were mistakenly omitted from our May 15 venture capital directory:

Accel Partners
1 Palmer Square,
Princeton, N.J. 08542
James Swartz (609) 683-4500

Adler & Company
375 Park Avenue, Suite 3303,
New York, N.Y. 10152
Frederick R. Adler, Yuval Binur:
(212) 759-2800

Hambrecht & Quist Venture Partners
235 Montgomery Street,
San Francisco, Calif. 94104
Bob Kunze: (415) 576-3300

Sevin Rosen Management Co.
200 Park Avenue,
New York, N.Y. 10166
Benjamin Rosen: (212) 687-5115

Modem makers adapt to ISDN

ISDN has the potential to wipe modem makers off the map. But terminal adaptors could help keep them alive

Like beach dwellers in hurricane season, modem makers are enjoying days of relative calm while they can. At the same time, they've got a nervous eye on the horizon, waiting for the day when integrated systems digital network (ISDN) finally roars ashore in all its advertised glory.

Modem sales are predicted to grow from 2.6 million units in 1987 to nearly 4.7 million units in 1992, according to researchers at Frost and Sullivan Inc. in New York City. But analysts are reluctant to forecast the modem market much beyond that date largely because of the uncertain impact of ISDN.

The all-digital network, which promises simultaneous transmission of voice, data and video signals, could theoretically wipe modem companies off the map when it arrives in force. How soon it will take hold in the United States is a matter of debate.

During the next two decades, most observers agree, ISDN will gradually replace the existing analog network and eliminate the need for modems, which translate computer language into something analog networks can understand.

So what are modem makers doing about all of this? For many, a life raft for surviving the ISDN flood may take the form of terminal adaptors (TAs). These devices are seen as the bridge between the vast installed base of existing computers and the new network.

Hayes Microcomputer Products Inc., the Norcross, Ga., company that claims the leading market share in personal computer modems, has developed a TA in the form of a board that can be inserted in PC expansion slots. Although Hayes has not released pricing and commercial availability information about its TA, prototype models have been used in exhibits at last fall's Telecom '87 in Geneva and in Southern Bell Co.'s rollout of ISDN technology in Atlanta this spring.

"I don't think analog use will peak for at least five years," says Dennis Hayes, who founded the $200 million-plus, privately held modem company in 1977. "But there's no question that ISDN is going to have a major impact on the country and our company. We want to be as ready for that impact as we can be."

The tough decision confronting Hayes is how much money to put into research and production of TAs at the expense of other products, when demand for ISDN is hard to gauge.

Hayes, observes Walth Sessoms, Southern Bell's vice president for Georgia, "has got to decide whether they're in the buggy whip business or the starter business."

Another potential manufacturer of TAs is Racal-Milgo, the modem maker based in Sunrise, Fla. It has developed prototypes in the form of a standalone box roughly the size of a modem itself. In January, the company began testing TA devices called Integrated Service Units in a trial with a Northern Telecom Inc. DMS 100 switch under the auspices of Bell Canada.

Like Hayes, Racal-Milgo, which garnered about $300 million in revenue last year, is faced with making a transition from a modem company to an ISDN-age communications firm.

As North American consumers begin sizing up ISDN, TAs will fill an expanding niche, says Robert Montgomery, Bell Canada's director for marketing.

"I don't think analog use will peak for at least five years"
Dennis Hayes, Hayes Microcomputer

"While ISDN-based services will be developed with the new ISDN terminals, it is absolutely essential that the large base of currently installed customer equipment also be compatible with the new ISDN services and terminals," Montgomery said when announcing the Racal-Milgo trial. "Terminal adaptors are the recognized method of achieving this."

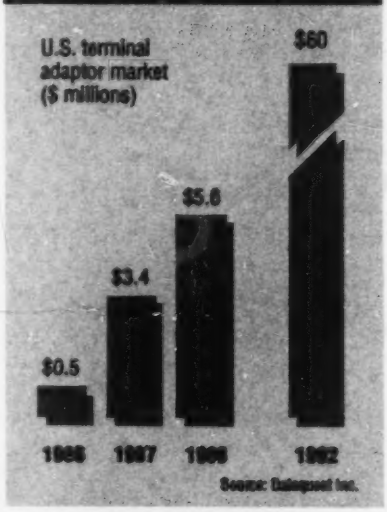
ISDN, however, will be a slow-moving hurricane at best, concludes Wiley Ehrke, ISDN product manager for Dracon, a division of Harris Corp. of Melbourne, Fla.

"Considering the fact that standards are still evolving, modems and TAs will probably coexist for a long time," Ehrke says. Harris is developing four different types of standalone TAs ranging in price from $1,200 to $1,600, he says.

Ultimately, TAs are seen as a transition product until computer manufacturers begin building telecommunications interfaces into most of their terminals. Victor Kreuguer, an analyst with Dataquest Inc. of San Jose, says he expects the TA market to be significant until at least 1995 to 2000.

After that, TA manufacturers may be in the same boat that modem makers are in today. □

Terminal adaptors: The bridge from modems to ISDN



TAs are seen as a transition product until computer manufacturers begin building telecommunications interfaces into most of their terminals.

The Lockheed subsidiary is a textbook example of how one U.S. company turned around its fortunes through manufacturing in the United States

Made in America

CalComp plots a world-class future

BY BRUCE C.P. RAYNER

When ex-Burroughs Corp. executive William Conlin came on board as president of graphics peripherals products maker CalComp Inc. in 1983, he inherited a company in trouble. Competition from the likes of Hewlett-Packard Co. was eating CalComp's lunch and company morale was in the doldrums. The talk at the top centered around which Far East country would be the best place to relocate manufacturing.

Five years later, and with capital investments of just $800,000 in the past three years, the $400 million maker of plotters, digitizers and display terminals has emerged as a sleek competitor. The Lockheed Corp. subsidiary now boasts improved market share, together with rising revenue, sustained profitability and a United States-based manufacturing thrust in a market characterized by intense price sensitivity.

The firm has done it largely through advanced manufacturing techniques, backed by clear-sighted marketing tactics. CalComp's apparent success in the peripherals market suggests there may be hope for other U.S. manufacturers who would rather invest domestically than emigrate to cheap labor markets in the Far East.

The man that Hewlett-Packard execs love to hate: CalComp boss Bill Conlin

David Bradley

Psychology has had a lot to do with the turnaround too. "I felt it was important to set about making an attitudinal change," says Conlin. "We had the ability to be the best, and we started pushing that idea to get people feeling good about themselves." Even though Lockheed does not break out CalComp's numbers, analysts say that since taking the reins, Conlin has doubled company revenue from $196.3 million for fiscal 1983 to an estimated $400 million this year.

Stable margins

More to the point, CalComp has kept its pretax profit margins more or less stable at around 10%, estimates Lawrence Harris, a senior analyst at investment brokerage Bateman Eichler, Hill Richards Inc., in Los Angeles. In a business where unit price is continuously dropping and sales channels are in upheaval, stable margins are a major accomplishment. Since 1983, price erosion has averaged between 10% and 20% per year on most company products, sources say.

Conlin attacked the corporate malaise on a number of fronts, but the two areas that needed the most attention were marketing and manufacturing. His intention was to transform CalComp into a market-driven company both in terms of sales focus and in terms of new products. As a matter of survival, he redirected the company away from its engineering focus so that by mid-1987, the company was completely restructured around the sales and marketing function.

A total of 25 vice presidents has been whittled down to 11, six of whom report directly to Conlin. One is Larry Sanders, an IBM alumnus who is CalComp's sales and marketing chief. Sanders has been the architect of the focus toward PC-oriented products, and for the consequent pressure on price-performance ratios. For example, he initiated the 38% price cuts on CalComp's 5800 series electrostatic plotters in the second

quarter of 1987 — an action that the company claims resulted in a doubling of revenue for that product line inside six months. "CalComp didn't turn things around until they created the new marketing approach, when they focused things around Sanders," comments Randall Stickrod, publisher of *The Stickrod File*, a graphics-industry newsletter based in San Francisco.

Relearning the basics

At the same time, Conlin began the laborious task of changing the corporate mindset toward manufacturing. After Conlin made it clear where he wanted to go, the initial step was to relearn the basics of manufacturing, says David Schlotterbeck, vice president and general manager of the plotter division. Despite CalComp's 25 years of manufacturing, "the facts were that we knew as little about [manufacturing] as most every other American company," he says.

Old attitudes began to change just as fast as the personnel. This was true for all three of the company's divisions: a digitizer operation in Scottsdale, Ariz.; a unit to manufacture graphics control devices in Hudson, N.H.; and a plotters group at the Anaheim, Calif., headquarters.

Three new general managers and vice presidents — including Schlotterbeck — were hired to oversee production, and by mid-1986 they had brought on board or promoted three new directors of operations. These were the new lieutenants whose responsibility it would be to implement just-in-time (JIT) manufacturing. The goal was to make all three factories world-class, meaning they were to become competitive in terms of price and quality with any manufacturer in the world.

JIT, in textbook terms, means streamlining production so that material arrives on the factory floor just in time for production. The goal is to have 100% quality parts arrive from suppliers, with no in-line inspection or rework required. For CalComp, textbook JIT was exactly what

Plotter inventory has been cut by 65%, yet plotter revenue has risen 62%

was applied to the problems. Conlin insisted that all employees read Richard J. Schonberger's 1986 book, *World Class Manufacturing, The Lessons of Simplicity Applied*. From vice presidents to factory floor workers, the pragmatic book began to influence the way everyone thought about their jobs.

With the new bible in hand and a mandate from above, the three directors of operations went to work simplifying manufacturing. At the plotter division, for example, operations director John Revere was given an ultimatum: Shape up the factory or it would be shipped to Singapore. So he took a $298,000 investment and turned it into $6.2 million in cost savings within two years. The investment was used for training in statistical process control (SPC) and for construction of office space for support staff right on the factory floor. And he charged the design team of the new 1023 model pen plotter with a 20-20-20 mandate: no supplier can be more than 20 miles from the factory; the number of fasteners used in the unit could not exceed 20; and the number of suppliers likewise. The final results came in at under 30-30-30.

Compared with the 1023's predecessor — the 1040 pen plotter — the improvements were promising: inventory turns were running at over 26 a year by early 1987, compared with 19 for the 1040; direct labor for assembly was down by over 80%; and CalComp sold more 1023s in the first 90 days than it expected to sell in the first year.

For the division as a whole, the results were equally dramatic. Inventory has been reduced by 65%; cycle times improved, production warehousing was eliminated and the number of suppliers has dropped by 40%. At the same time, revenue has risen by 62%, the company claims.

The display division has also been zealous about JIT, but with one twist. A large part of the value added for display products is in stuffing printed circuit boards. As it is highly capital intensive, the division has opted to

CalComp's sales and operating income

*Estimate: Lockheed does not break out CalComp figures

Sources: Company reports; Bateman, Eichler Hill Richards Inc.

Price erosion isn't stopping CalComp from keeping sales soaring — and margins up

David Bradley

"We knew as little about manufacturing as most every other American company," says David Schlotterbeck, general manager of the plotter division

keep the functional factory structure. The board line accounts for nearly half of the total factory, assembling about 4,000 boards a month for all the division's product lines.

Like the other operations chiefs, James Bell, director of operations at the display division, has shunned automation. He removed a sophisticated conveyor system because it was not adding any value and put in its place a horseshoe-shaped production line for circuit board assembly. As a result, board cycle time has dropped from 12 weeks to three weeks and factory space is down by 25%.

The improvement in circuit board assembly at all three divisions is a crucial step toward reducing the reliance on foreign sourcing. For instance, the plotter division is currently ramping up production for JIT-based board stuffing in the display division's facility for one of its newer products. If total cost of board assembly can be reduced for other new products as they come on-line, it is feasible that all board stuffing could return to the United States.

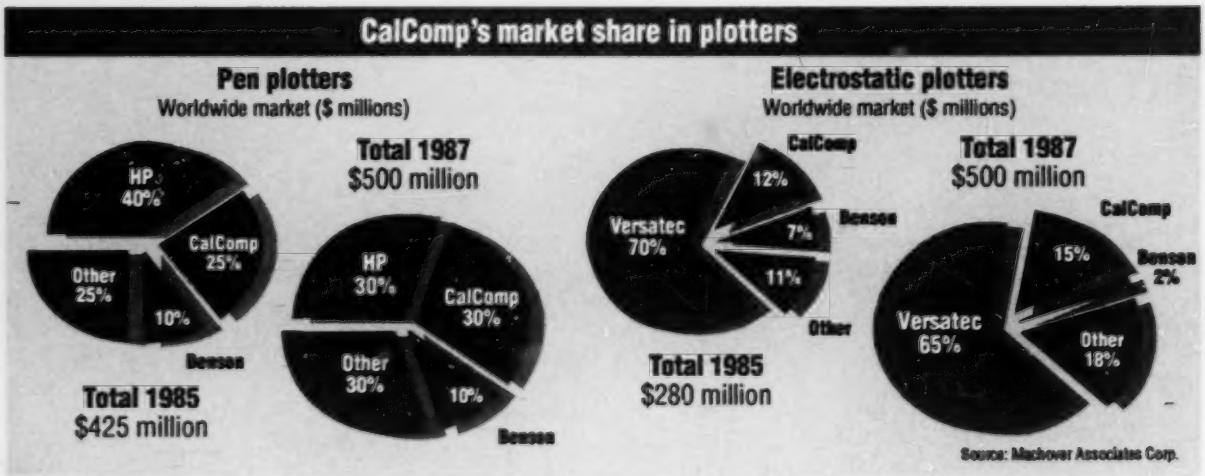
The digitizer division has already brought all its printed circuit board stuffing back in house from Singapore. "With Phoenix labor, we beat the Singapore price," says Gary Long, vice president and general manager of the digitizer facility.

Calcomp is also paying closer attention to its distribution channels. Sales through distributors and value-added resellers such as Entre Computer Centers Inc. have risen from zero five years ago to about 40% of total revenue today, the company reports. And the mix of direct sales to OEM accounts has switched from a 55-45 split to a ratio of 20% direct and 80% alternative channels, reflecting the move to PC-oriented equipment.

IBM's business

Similarly, IBM used to account for a sizable chunk of total business, and that has since dropped to about 25% with expectations of a further decline to 15% over the next few years. The company insists that the IBM business, mainly in graphics displays, is important; it's just that the rest of the company has been growing at a faster pace.

Bhanu Bhattasali, director of the printer group at market researcher Dataquest Inc., is bullish on CalComp's new look. "CalComp is moving very aggressively; they are positioned well with a full line of graphics devices," he says. That full line of product was a clear attraction to Beaverton, Oregon-based Mentor Graphics Corp. In a $3 million OEM deal inked in January, CalComp beat out HP and Versatec to supply the



CalComp is giving HP a run for its money in pen plotters — and beating up on Versatec in electrostatics

Sales and marketing chief Larry Sanders has been the architect of the focus toward PC-oriented products

CAE giant with pen, thermal-transfer and electrostatic plotters.

Explains Mentor president Gerard Langeler: "We did a very exhaustive analysis of both product technology currently and the future plans of the major players in the graphics-peripherals business. [We looked for] two things: quality and breadth of product line, so we could deal with one supplier. CalComp not only won that evaluation but it was a reasonably clear win; it was not a nail-biter."

Langeler was well aware of the part played by CalComp's revamping of manufacturing: "That was part of our analysis. Their quality approach to manufacturing is particularly important for electromechanical type devices which are much tougher than electronic devices to manufacture to very high quality; CalComp appears to have done a very good job on that. They will by far and away be the major percent of the hard-copy portion of our business," he predicts.

A long way

It is clear that CalComp has come a long way since it was created by its former parent, Sanders Associates Inc., a military electronics company. In 1986, Sanders was acquired by Lockheed, and CalComp became a major component of Lockheed's Information Systems Group (ISG). Lockheed maintains a hands-off approach when it comes to CalComp's strategy and tactics, and has not contributed significantly to CalComp's restructuring investment. "We run the company independently," asserts Conlin. Today, digitizers account for about 10% of total sales while plotters make up 50% and displays the remaining 40%.

However, CalComp has not always gotten it right. In 1984, it established, with much fanfare, a separate business unit for PC peripherals that it hoped would help drive the company toward $1 billion in revenue by 1990. The unit helped give PC-oriented products a start, but it did not emerge as a viable independent operation and was rolled back into the three basic divisions.

Despite these occasional setbacks, it now seems evident that CalComp finally has its act together. Earl Payton, chairman of $20 million-a-year Cowden Metal Specialties, a Chino, California-based maker of cabinets, says that he used to do some work for CalComp nine years ago. "They were absolutely terrible, they had no business plan and were so fragmented it was truly a joke," he says. Now, says Payton, CalComp is like a new company. "They have made a ten thousand percent improvement."

But CalComp still has its work cut out in trying to stay ahead of the pricing game. Arch-enemy HP has recently vaulted into the electrostatic plotter arena for the first time, challenging both Versatec and CalComp with its new 7600 monochrome model whose price begins below $23,000. "We think it will just devastate Versatec," gloats Conlin. So what does he think will keep CalComp immune? A new line of monochrome electrostatics to be unveiled next month — and yet more pressure on manufacturing costs. □

CalComp is *not* for sale . . . but

Lockheed is selling off one subsidiary. Will CalComp Inc. be next? Most say no, but it could depend on the price.

In early May, CalComp's parent, Lockheed Corp., put one of its Information Systems Group (ISG) companies up for sale. The announcement spawned speculation that maybe Lockheed was changing its mind about the remaining handful of ISG companies, including CalComp.

At press time, Dialog Information Services Inc., one of Lockheed's electronic information services companies, was still on the market awaiting a buyer. The asking price is reported to be in the $200 million range, twice the company's annual sales and 10.5 times its earnings. Two information-services giants — McGraw-Hill Inc. and Mead Data Central, a unit of Mead Corp. — are reportedly interested.

The official word from Lockheed is that CalComp is safe and sound just where it is. "The company has no other plans for divesting any other divisions," comments Richard Bennett, director of marketing at Lockheed's ISG.

But what Lockheed might say and what it might do — under the right circumstances — might be quite different things, analysts say. "I wouldn't be surprised to see them sell [CalComp] at some point if they find someone willing to pay what they consider a good price," comments Paul Nisbet, first vice president at Prudential-Bache Securities Inc., in New York City. A good price, analysts say, would be something over $400 million.

David Bradley

HP turns to RISC and Unix to turn around the company

Hewlett-Packard bet early on RISC and Unix for its Spectrum computers. Those bets are now paying off, as HP challenges both IBM and DEC

BY MARY JO FOLEY

Some analysts are calling Hewlett-Packard Co. the "new Digital Equipment Corp." That's quite a turnaround for a computer company which is still largely viewed as an instrument maker in some quarters.

However, HP is, in fact, a strong player in computers. For fiscal 1987, ended October 31, an estimated 65% of its total $8 billion revenue was attributable directly to microcomputer, minicomputer, software and peripherals sales.

Even Hewlett-Packard's critics grudgingly agree that it seems to have pulled off a coup in the past couple of years by switching computer architectures and introducing a Unix-based line in a way that's proven to be relatively painless for its customers. The dual strategy also put the brakes on HP's loss in market share, making it a clear challenger to the computer "establishment" — giants like DEC, IBM, NCR Corp. and Unisys Corp.

In many ways, analysts say, the success of HP is testimony to the growing importance of a nonproprietary operating system (Unix) and a new microprocessor design (reduced instruction set computing, or RISC) to the computer industry.

But despite HP's apparent success, the changeover to Unix and RISC has not been particularly easy. Analysts say the transition has cost the company an estimated $250 million in R&D time over the past five years. HP's Spectrum team also had to deal with the frustrations involved in an almost year-long product introduction delay.

Manufacturing Systems Group VP William Parzybok credits HP's top management with the decision to plunge into RISC and Unix

First in, first out

However, several years ago, with the announcement of its midrange line of Spectrum computers, HP was the first of the big computer firms to declare backing for RISC. As RISC fever has grown and various Unix versions have gained prominence, that strategy has positioned the company well, analysts say.

William Parzybok, vice president and general manager of HP's Engineering and Manufacturing Systems Group, suggests the decision to switch architectures and operating systems was based largely on technical criteria. "We made extensive measurements of what different computer architectures did," Parzybok says. "We did this with our own computers in our own labs. We chose the RISC architecture based on what people were actually doing with their systems."

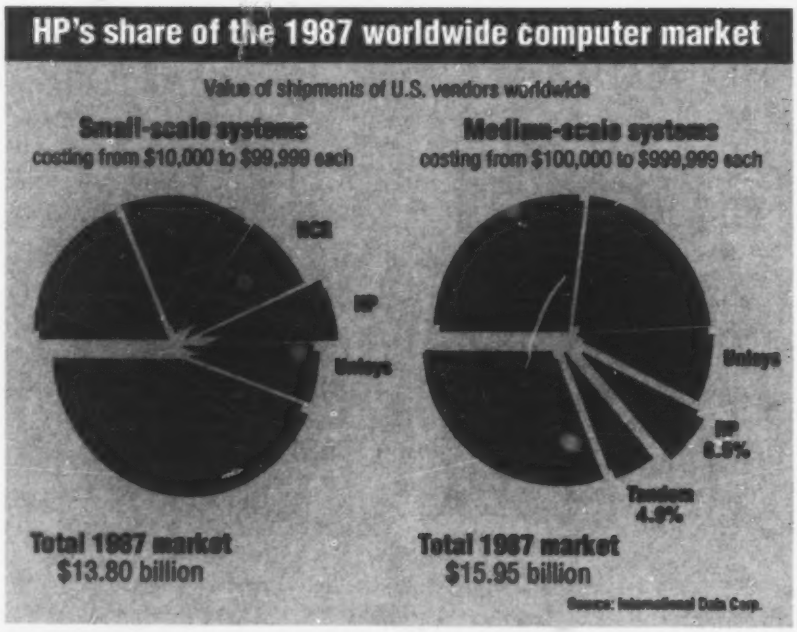
Once the decision was made, Parzybok says, the company never looked back. "Management made a real commitment to the architecture," he recalls. "We put our money where our mouth was."

The computer industry will be in a better position to judge the soundness of HP's investment within the next year or so. That's when HP's

two top competitors, IBM and DEC, are expected to fully launch their own Unix and RISC strategies. IBM already has made exploratory forays into both areas with AIX, its recently announced Unix scheme, and its RT personal computer; Digital Equipment has been pushing half heartedly its Ultrix Unix product for some time, but has yet to introduce a RISC-based system.

Other traditional midrange vendors, such as Data General Corp., NCR, Unisys and Wang Laboratories Inc., likewise are expected to capitalize on Unix and/or RISC. At the same time, niche-oriented companies — targeting multiprocessing, parallel processing, work group computing, and networking environments — are expected to join the Unix and RISC charges.

Add to this hodgepodge the ongoing standardization debates regarding "whose Unix" and "whose RISC chip" are "best," and you have a picture of the uncertain world into which HP has plunged via its so-called Precision Architecture systems, known in house as Spectrum.



HP is once again a force to be reckoned with. Some are even calling it the "new IBM"

Risky RISC?

"Our decision about going with RISC [and Unix] was never seen within HP to be as risky as the press portrayed it," claims Timothy Haney, sales manager for HP's technical computer group. "Adherence to standards was what was seen as risky, as were decisions regarding open environments, timing, and customer freedom." Indeed, the way Haney tells the story, it almost seems as if HP couldn't have improved on its strategy for switching architectures if it had had a tailor-made business plan to follow.

But in the early 1980s, when most of the RISC players were start-ups — such as Celerity Computing, MIPS Computer Systems Inc., Pyramid Technology Corp., and Ridge Computers — HP's decision to go the RISC route looked anything but sure. However, "an overwhelming amount of data pointed to RISC" as the superior choice, Haney says. RISC's promised benefits — reduced design complexity, and thus increased price/performance — seemed to be just what the doctor ordered for HP's case of midrange malaise.

Once the decision was finalized, Haney says, developing the hardware was relatively easy. Even devising a version of Unix optimized to run on its new RISC systems was relatively straightforward, as evidenced by HP's rapid shipment in late 1986 of its first Series 9000 models. The hard part was writing a new, fully compatible version of MPE, the company's proprietary operating system for its RISC-based machines. But after much publicized delays and resulting warnings of customer defections — which never materialized — HP shipped its first commercial models by the end of 1987. In what turned out to be a stroke of brilliant foresight, HP also established so-called Software Evaluation and Migration Centers, complete with HP computers and technical personnel, to aid independent software vendors, and more recently, individual customers, in moving their applications software to the new HP systems.

Observers say Spectrum has enabled HP to stem its decline in midrange computer market share

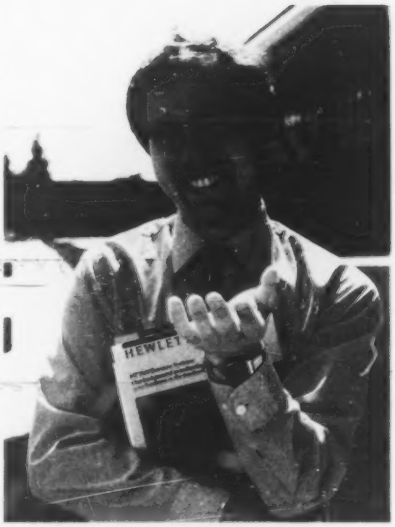
Following an April 1988 rollout of seven new Precision Architecture products, the family now consists of full-fledged commercial and technical lines. Both share common central-processing units (based on HP's proprietary RISC chips), datacommunications facilities, databases and compiler software tools. The only difference between the two lines is the type of software they run.

The business systems, which run HP's proprietary MPE XL operating system, are an extension and replacement of its existing 3000 series. The technical systems, known as the HP 9000 series, run HP-UX, HP's version of Unix, based on both AT&T's System V and Berkeley Unix.

This scenario is not exactly static, though. With the debate over the future of Unix as an "open" system, and HP's decision to join with IBM, DEC and others in forming the Open Software Foundation, the exact "flavor" of HP's Unix may shift over time.

Meanwhile, HP's strategy appears to be paying off. Already, a number of industry watchers say HP's Precision Architecture has enabled HP to

stem — and even begin to reverse — its decline in midrange market share. According to the Framingham, Mass., market research firm International Data Corp., HP captured a solid 6.5% of the midscale ($100,000 to $999,999) computer market last year. It likewise garnered 6.4% of the total value of shipments of U.S. vendors worldwide of the small-scale ($10,000 to $99,999) computer world, says IDC. Whether HP will steal market share from firmly entrenched IBM or DEC is questionable. But HP, with its claim "that it will compete with anyone on service, product quality and price/performance," in the words of IDC analyst Art Hutchinson, "is one of the only companies that can still say that credibly."



David Hoover, product marketing manager for MPE systems for HP's commercial Systems Group

Well positioned

"HP's well positioned to be the third player in the top tier" of midrange vendors, concurs John McCarthy, the director of professional systems services for Forrester Research in Cambridge, Mass. "They've got a big jump on the market with RISC." The Unix-RISC combination positions them, even more importantly, to capture a sizable piece of what McCarthy calls the "high-end server" market. As the traditional minicomputer market continues to decline, personal computers networked with high-power servers will be the new growth segment of the industry, he says. McCarthy predicts that 47,000 of these servers will be shipped this year; 173,000 will be shipped by 1992. HP could capture as much as 15% to 20% of this market by then, he claims.

In addition, HP is showing a strong understanding of the directions the computer market is taking, industry watchers say. Unlike IBM and DEC, "HP already has a strategy based on supporting PCs [personal computers], rather than terminals," explains Marty Gruhn, vice president of The Sierra Group, a Tempe, Arizona-based market research firm.

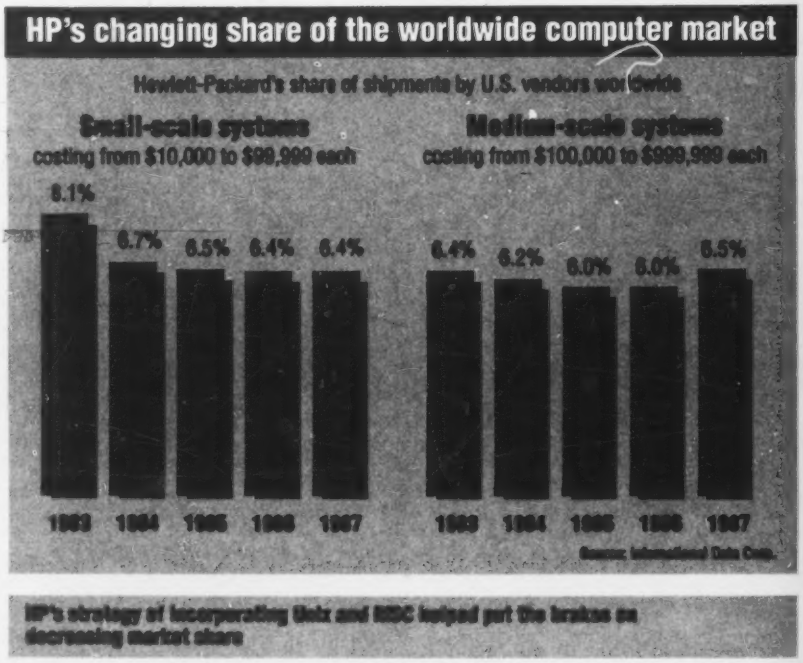
On the downside, while "all of its produce niches are filled, in some cases, HP's products aren't as viable as they need to be," Gruhn says. For instance, HP touts connectivity between its business and technical computers — thanks to its use of the same CPU, chip set and datacommunication links. However, almost none of its customers are at a point where it currently needs to interface these various systems. Another area on which HP needs to concentrate is marketing. The company's salesforce is still much more technically oriented than commercially oriented, although remedying this shortcoming is a corporate priority, Gruhn acknowledges.

In the coming year, HP also will need to build up its stable of application software vendors — especially ones willing to write for its NewWave interface. So far, NewWave is available for HP PCs only; but within a year, the interface could be available for the Precision Architecture systems. However, a lot will depend on what happens in the "look and feel" suit launched by Apple Computer Inc. against HP over alleged similarities between NewWave and Apple's system software.

At the same time, HP is sure to be working on a parallel-processing version of its RISC-based series, and possibly some lower end CMOS-based minis to round out its line, according to Forrester Research's McCarthy. Some type of clustering scheme, along the lines of DEC's VAXCluster, also could make its debut by early 1989, he says.

But the major hurdle for HP with its Precision Architecture line will be in "making the portability of software transparent to users," while simultaneously making the benefits apparent to them, says David Hoover, product marketing manager for MPE systems for HP's commercial systems group. Both RISC and Unix are technologies which are best appreciated when least noticed. HP's challenge will be in keeping them that way. □

Lane Erkeis



HP's strategy of incorporating Unix and RISC helped put the brakes on decreasing market share

Computer makers look to emerging offshore markets

It's been a banner year for U.S. manufacturers abroad, thanks in part to the dramatically lower dollar and a new generation of computer gear

BY MARTY CHASE

For the U.S. computer industry, 1988 is rapidly becoming the "Year of the Export." The chief executives of many of the country's largest computer makers, like Digital Equipment Corp. and Hewlett-Packard Co. and IBM, all acknowledge that fact. But it's a trend that many smaller companies, including new electronics industry start-ups, are starting to take advantage of as well.

What is happening, in a nutshell, is a boom in computer buying throughout the world, especially in Europe, but also in many key Asian markets and even in some developing world nations. "There's been a tremendous boom in our industry throughout the world," says Charlotte LeGates, an executive at the Computer and Business Equipment Manufacturers Association, a leading trade association.

"Business is going great guns for us," says John Young, chief executive of Hewlett-Packard. "It is one of those rare times when almost everything is going well. Our exports are strong in all parts of the world." HP will export more than $1.5 billion this year, he adds.

"Of course, the lower dollar has been a big factor," Young says. "We think it'll go even lower [in Japan], maybe as far as 100 yen to the dollar. Frankly, we wouldn't be surprised to see it go that low. But it all depends on the rate of change — how fast it falls. Nobody wants to see it get there too fast. We would face some real problems if it fell too quickly because it would probably crimp the ability of the Europeans and others to keep on buying U.S. machines."

Kenneth Olsen, chief executive at Digital Equipment Corp., concurs. For his own company, however, he notes that half of DEC's business is overseas. "This has always been the case, so the dollar impact is not as great on us as it might be for some others," he reasons.

HP and DEC are not alone. Compaq Computer Corp. also recently reported it had tripled exports in 1987, up to roughly $380,000, about a third of its entire revenue. And earlier this

Export dos and don'ts

A brief listing of exporting "dos and don'ts" provided by the Commerce Department as part of its Export Now program.

DO develop a business and marketing plan before you start. Have clearly defined goals and objectives and know how you are going to reach them.

DO get top management's commitment for the long haul. It takes time, money and patience to be successful. It may be years before you see results, especially in hard-to-crack markets like Japan and China.

DO exercise caution in selecting your representatives overseas. Evaluate your foreign staff personally. These will be the people representing you and handling your products.

DO establish a base for orderly growth. It makes sense to start with one or two foreign markets first, perhaps in places like Canada or Britain, where you don't face language barriers. Start fairly small and build upon that base.

DO modify or change your products to comply with local rules, regulations and culture. Make the needed modifications to products at the factory.

DO print sales, service and warranty data in the local language. And, another consideration just as important, make sure you have a solid translator. Cutting corners on this can spell disaster.

DO consider using an export management company. This is good advice especially for a smaller firm. Export management companies are facilitators who will sell your products overseas without necessarily taking title to the goods.

DON'T be a fair weather exporter, letting the export side slide when domestic business is good. That damages your reputation and leaves you without any recourse when your home market falls off.

DON'T treat exports as an afterthought. If you try to boost domestic sales through advertising, discount offers, special promotions, etc., then apply these same incentives to your overseas markets too.

DON'T assume the same marketing techniques work everywhere. You must study, learn and follow the various cultures. Negotiations can be long-winded and often follow a prescribed set of rules.

DON'T fail to provide support services. All products need servicing. If you don't provide it, your reputation will suffer. □

year at an elite CEO gathering of the 75-member Business Council in Hot Springs, Va., IBM's John Akers said his company is extremely pleased with the "very strong market for exports, most notably in Europe."

IBM's international efforts

"Business in the industry is good," Akers asserts. "For us, it's better outside the U.S. than it is inside the U.S. Markets in Japan and Europe are growing the fastest, and we expect this to continue, certainly for the rest of this year."

Akers and others note that the current boom in buying computers and related equipment seems to be fueled by several factors: first, there is new low-end and relatively low-cost equipment coming onto the market; secondly, sophisticated high-end machines are becoming standard. Add those factors to the low dollar and you have a situation in which computers and products have become one of the nation's strongest exports, accounting for nearly one in every 10 dollars on the export side of the U.S. trade balance.

But the industry giants have long been major players in international trade. The big story in the new export boom is the emergence of a new wave of international competitors, many of them in the electronics industry, which are boosting their overseas sales by leaps and bounds.

Richard Cavanagh, a vice president at McKinsey & Co., analyzed a number of these companies in an extensive report called "Winning in World Markets."

Cavanagh believes there are some important lessons to be learned from the way these outfits approach exporting. "In a way, they're the same as their predecessors, but in an important way they are different," he says. The basic difference with this new breed of international firms is they are competing on the value of their products, he says, "not simply on cost."

A prime example is Cray Research, which is moving aggressively into Japan, taking on the Japanese supercomputer giants like Fujitsu Ltd. in its own backyard. Cray has established country organizations that handle marketing, sales and service functions, and give local managers plenty of room to maneuver. For example, the country manager at Cray has considerable control over marketing of used equipment in that territory, can determine trade-in credit for upgrades and sets all service fees, Cavanagh notes.

Cray also has the managers of its six leading overseas subsidiaries report directly to internal boards of directors, which include their peers from various functions and U.S. regions. These are chaired by executive vice presidents. And, significantly, all country managers have direct access to John Rollwagen, the chief executive. "In effect, we govern, not manage," says Marcelo Gumucio, marketing chief at Cray.

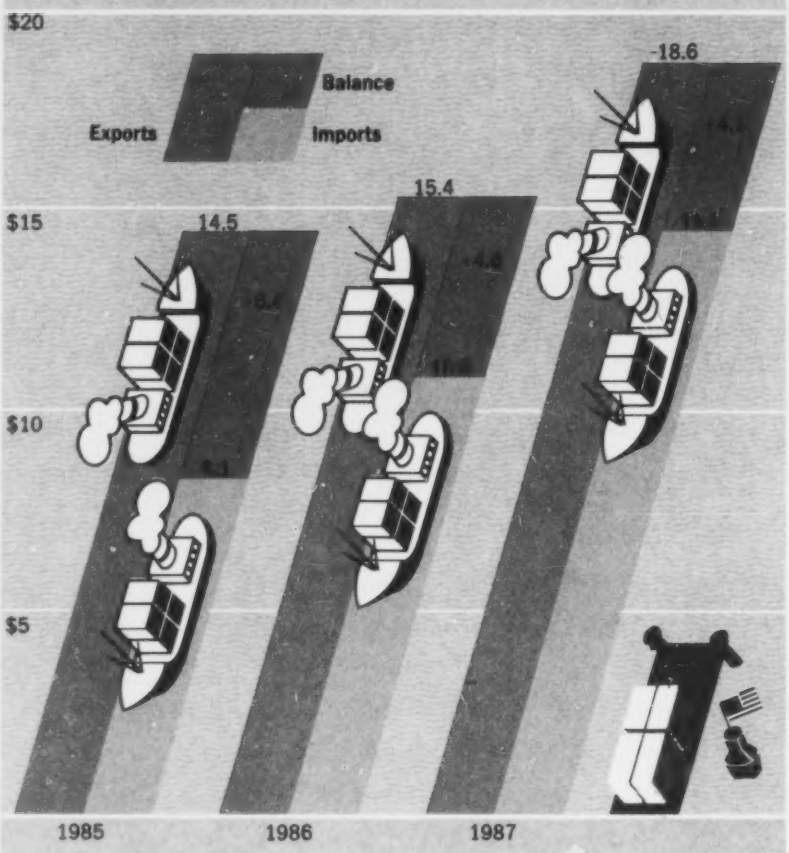
Smaller firms can also benefit from the export boom. The world market is about four times larger than the U.S. domestic market," Commerce Secretary William Verity said at a recent Washington briefing. "With the dollar down, exporters will find that additional product lines may now be competitive in both old and new foreign markets."

Verity is spearheading a Commerce Department program called Export Now to boost U.S. exports, and the timing couldn't be better. "This campaign is aimed primarily at firms which have dismissed the idea of exporting in the past," he says. This is the time they should be "reexamining" this decision, Verity says.

Export Now does not include funding for any new government programs or money to directly aid exporters. What it will do is help direct companies, especially small- and medium-sized companies, into the export business, providing a range of market data and other informational aids. □

COMPUTER TRADE BALANCE

U.S. exports and imports of computers and related products ($ billions)



Source: U.S. Department of Commerce

Computer exports are increasing rapidly, but imports are rising at an even faster rate.

Phil Scheuer

The Navy launches a parts program to spur productivity

Called RAMP, the South Carolina-based experiment is already eliciting keen interest from IBM and other prime contractors

BY ANNE HYDE

A $50 million contract may seem miniscule when compared with most Department of Defense (DOD) contracts, but there's one new U.S. Navy contract which may be worth watching. It's called RAMP, for Rapid Acquisition of Manufactured Parts, and its contract managers claim it could help the United States become more competitive in low-volume manufacturing of electronic parts.

RAMP is the Navy's answer to controlling costs and guaranteeing rapid acquisition of replacement parts, including electronic components, for ships and aircraft. Ground was broken last spring in Charleston, S.C., for the new RAMP test and integration facility to serve as a model for automated manufacturing of small machine parts and printed wiring assemblies. Within two and a half years, the facility is expected to begin turning out small ship or aircraft parts and circuit boards.

Prototype factories of the future will be built. A computerized description of a part will drive machines and robots to not only manufacture the part, but also perform test and measurement. By 1991, officials hope the project will lead to facilities for producing small machined parts at the Charleston Naval Shipyard, the third largest shipyard in the United States, and cells for turning out printed wiring assemblies at the Naval Avionics Center in Indianapolis, Ind.

M.C. Velarde

RAMP implementation chief Bernard Farley: "What we want to do is push this JIT technology out to component vendors"

Navy inventory control points will eventually be tied into a computerized bid-order database. RAMP will use digitized technical data and drawings, along with computer-integrated manufacturing technology to turn out limited runs of low-demand small machined parts and circuit boards.

The Navy has stong reasons for wanting to transfer this technology to private industry. "Our motive by transferring it to private industry is to improve our own industrial base . . . What we want to do is push this just-in-time technology out to component vendors," says Bernard F. Farley, RAMP implementation manager at the Naval Supply Systems Command in Washington, D.C. Another critical objective is to reduce the procurement leadtime on some military components from 300 to 30 days.

At the same time, there is also widespread interest in the technology because private industry could eventually apply the RAMP concept to a more ambitious parts-on-demand capability. For this reason, a number of U.S. electronics companies — including IBM — are currently evaluating the program.

IBM's interest

Indeed, Big Blue is so interested in the project that a company representative has been assigned in Charleston specifically to track the RAMP project with hardware and software. "Right now, our motive is to demonstrate that IBM has the capability that RAMP is looking for in terms of applications and commercial off-the-shelf hardware and software. We're looking at this as more of a chance to showcase our technology rather than to make a lot of money from any initial supply contract to RAMP," says Hossein Parsapour, ac-

count market developer for IBM.

"I think the most important thing this could demonstrate is the ability to produce replacement parts on demand. Potentially, companies that are in the business, such as IBM, could use these kinds of RAMP facilities rather than maintain huge inventories. In most cases, companies project how many parts they need and maintain stockrooms and storage area. In that case, you end up wasting a large amount of dollars and resources to stock the parts. In this case, you can order through the system for replacement boards on demand," Parsapour says.

Parsapour notes that much of the technology already is out there, but he says it has yet to be widely applied. "This brings together a lot of components that already exist. This addresses the complete package, starting from the storage of electronic data and the storage of all parts without human intervention on the factory floor," he says.

Pockets of this exist, but the RAMP facility is the first to bring the whole thing under one roof," Parsapour explains. He says IBM could supply companies with RAMP-like capabilities, and also apply the technology internally. "There are companies that might decide they can use this to be more competitive in producing parts for the military," he adds.

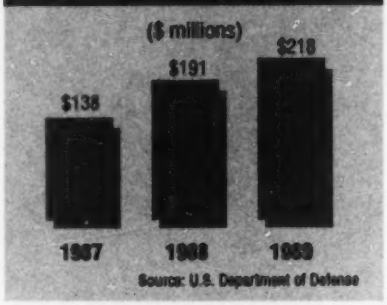
Broad interest

IBM isn't the only one interested. Among others, Digital Equipment Corp., Prime Computer Inc. and Tandem Computer Inc. all are vying for contracts to supply RAMP hardware and software.

Through a program designed to encourage technology transfer, as many as 200 companies have been invited to participate in seminars to see what the RAMP project has to offer. Private industry is being invited to participate either by sharing technological expertise or lending associate staff members to the project to learn about the technology and bring it back to the companies.

Westinghouse Electric Corp. already invested $2.5 million of its own money in 1985 as part of a $4 million joint project with the Navy to demonstrate a workable flexible manufacturing cell for printed circuit wiring assemblies. "It was a multi-approach

DOD's spending on RAMP and related projects



The DOD will not break out RAMP's exact budget, but RAMP accounts for the major part of this program called Computer Aided Acquisition and Logistics Support

at the time. There was a great deal of sensitivity as to the cost of spare parts. We wanted to take advantage of manufacturing small parts and printed wire assemblies. Specifically, we were building on our own automated electronics assembly facility that we designed in College Station, Texas," says Richard Drake, director of advanced production technology at Westinghouse's Electronic Systems Division in Columbia, Md.

"The technology was there. What we wanted to do was to package it. The internal project was designed to see how we could reduce costs and

One goal is to cut lead-times on some parts from 300 to 30 days

leadtimes. We wanted not only to be able to use it internally, but also to successfully demonstrate it to the Navy," Drake explains.

He notes that Westinghouse and the South Carolina Research Authority, a key RAMP sponsor, now are discussing possible enhancements that Westinghouse might provide for the RAMP project. The technology is old enough, according to Drake, but it has so far been limited to high-volume production and a small range of products.

"Flexibility is becoming quite the demand. The Japanese are great at high volume. But they know now that the Koreans are beating their pants off in this area of low-volume manufacturing. You're seeing it already in the area of mechanical parts. For electronics, it's here and now and it's just a matter of getting the mindset ready for it," Drake says.

Small lot sizes

"We're talking about producing a wide variety of random printed wiring assemblies in an eight-hour day in lots as low as one," adds Farley. "Industry is finding that in order to compete, they've got to respond to customers in small lot sizes," he says.

Although there are islands of automation where the technology is being used now, it is so far limited to specialized applications buried in very large electronics companies, according to John Simpson, of the National Bureau of Standards, which is heading up a joint effort among industry and government to come up with a technical data standard for a digitized technical data package. "What we're attempting to do is demonstrate that it can be scaled down to smaller companies," Simpson says.

Under the leadership of the South Carolina Research Authority (SCRA), the American Manufacturing Research Consortium was established to bring together the technical expertise to develop RAMP. The consortium includes Arthur D. Little Inc., the Battelle Memorial Institute, Grumman Data Systems, Ingersoll Engineers Inc. and the SCRA.

The research authority is a nonprofit state agency that promotes high-technology research and development in South Carolina. It won the initial $50 million contract from the Navy to develop the plans and high-level specifications for RAMP.

But Curtis Holcombe, an Arthur D. Little official, believes it will take some time before electronics companies are as enthusiastic as the aerospace community over the RAMP project. Since all of the technology is nonproprietary, companies aren't rushing to embrace the project, he says. "The business climate would have to change for electronics companies before there would be a lot of enthusiasm because they generally consider their design to be proprietary," Holcombe says. But cooperation between companies is "absolutely going to be necessary." □

CIM sales in Europe send the right signals to U.S. vendors

U.S. suppliers of automation equipment are teaming with European partners to cash in on the worldwide CIM upswing

BY JACK GEE

Computer-integrated manufacturing (CIM) is upsetting the cozy convictions of manufacturers of the die-hard generation. As new products are rushed to market at an increasingly dizzying pace, old assembly-line technology cannot cope with rapid changes of style and models. In the United States and Asia, flexible manufacturing systems (FMS) are playing a growing role in meeting these new challenges. In Europe's factories, automation and flexibility are establishing an even stronger foothold.

Bipe, a market research firm based in Paris, reports that last year Europe accounted for 26% of a $36.6 billion world market for numerical controls, robots and programmable logic controllers (PLCs), the workhorses of automated factory systems.

"That's twice the value of the PLCs which will go into U.S. plants," says Philip Emerson, European marketing manager for industrial systems at Texas Instruments Inc., which is headquartered in Villeneuve-Loubert, on the French Riviera. The Texas company is a leading vendor of PLCs, computer-based devices which, once instructed by a production engineer, continuously start, stop or alter the behavior of motors, valves, actuators and other devices.

In data-processing equipment for CIM, Europe shows the same lineup of suppliers as in the United States. Once again, IBM leads the pack in manufacturing management systems, followed by Digital Equipment Corp. and Hewlett-Packard Co. In computer-aided design and manufacturing (CAD/CAM), the familiar logos of Apollo Computer Inc., DEC and Sun Microsystems Inc. are highly visible. Philippe Fremeaux, client case team leader at market researcher Bipe says: "European companies are paying the price for slipping behind in the race for industrial software development."

The list of suppliers of CIM equipment in Europe includes the familiar names which are well established in the United States and Japan. Siemens AG, the West German electrical and electronics giant, made an unsuccessful bid to buy Allen-Bradley Co. three years ago in an effort to beef up its own position as a factory-automation supplier.

European companies are also alert to opportunities to team up with U.S. partners. DEC has formed Sesam, a 50-50 venture in factory automation with Comau, a robotics subsidiary of Fiat. This partnership is targeting revenue of $230 million by 1990. In a parallel match, IBM has teamed up with Elsag, the factory-automation arm of Italy's IRI-Stet electronics holding.

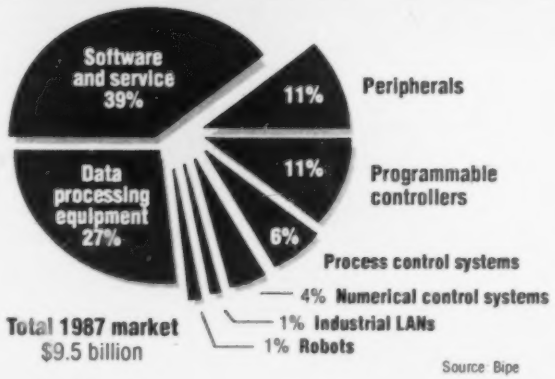
Setting their sights on the CIM market in the United States, European firms are signing up American partners too. The most promising alliances to watch are in West Germany, where Siemens and Westinghouse Electric Corp. have joined forces and AEG AG, a subsidiary of Daimler Benz AG, has bought Gould Inc.'s industrial automation division.

The Siemens-Westinghouse venture, which is U.S.-based, is 51%-owned by the American partner, which will contribute robot, process control and other businesses. The bulk of the sales are expected to be in the United States, where Westinghouse outsells Siemens in these sectors. Westinghouse is likely to be the leader in the factory-automation element, while Siemens can expect to show its strength in circuit breakers.

Europe's PLC power

But in PLCs, where they have been able to apply their long-standing experience in electromechanical engineering, the Europeans have been faring much better. Siemens, Telemecanique of France and ABB, the new partnership between Sweden's Asea AB and Switzerland's Brown Boveri Group, are performing well in this market. In France, Telemecanique, currently the target of a takeover battle for its expertise in this sector, is being challenged by April, a joint venture between Renault Automation and Merlin Gerin, a subsidiary of the big Schneider engineering and electronics group. Britain's General Electric Co. — no relation to GE of the United States

European flexible manufacturing systems market



Source Bipe

— has a strong position in PLCs on its home ground.

However, Europe's flagship computer companies, such as Britain's ICL, Italy's Ing C. Olivetti and Co. and France's Groupe Bull have failed to make an impact in the industrial market. Even Siemens, although powerful in many aspects of industrial data processing, is weak in applications.

Texas Instruments' Emerson argues: "FMS is even more crucial in Europe than in the world's other factory environments. The U.S. and Japan are big, single, homogenous markets. But Europe is composed of small, nationally oriented marketplaces. That means production runs are shorter than in U.S. factories. The European accent is also on batch manufacturing rather than on hard automation."

Automating at Alcatel

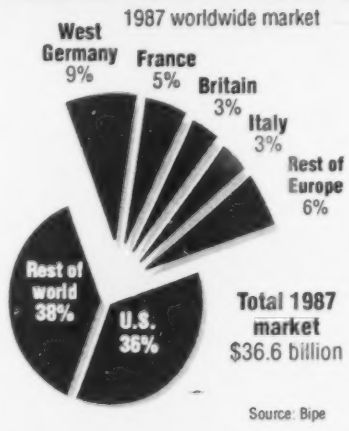
In Vienna, Helmut Amler, director of manufacturing at Alcatel Austria, is responsible for one of Europe's most highly automated plants. It produces the Amanda private branch telephone exchange (PBX), developed there before France's Alcatel took over ITT Corp.'s telecommunications business. The firm ships this entirely digital product to 50 countries. One-quarter of the output is sold in the Pacific area against tough Japanese competition.

Alcatel's Amler says: "We could not compete in this market unless we had fast information flow through our commercial and marketing operations right down to the factory floor. Only a few firms worldwide have achieved our level of CIM, which is based on a higly integrated DEC/IBM computer network. You have to be in CIM nowadays. Otherwise you flop. At ITT, we got the message early. We began working here with computer-supported test machinery 10 years ago when CIM was unheard of."

The success of Alcatel Austria's flexible manufacturing system is reflected in its production of printed circuit boards for public switching systems and PBXs. Amler explains: "We make 2,500 different types of board. We can even do batches of one. CIM has enabled us to get from the component stage to a complete PBX in only five days — compared with 48 days three years ago. And that means we are making production savings of $6 million a year." Alcatel has acknowledged the Vienna plant's performance by giving it worldwide responsibility, spanning ITT's former empire, for software technology, artificial intelligence and expert systems.

In West Germany, Nixdorf Computer AG's interest in automated manufacturing stemmed from its own requirements as a maker of minicomputers for office users. But now it is finding markets of its own for CIM among manufacturers. "This is a new business opportunity for a company which has not been visible until now on the factory floor," says Hans-Joachim Mosler, manager of Nixdorf's newly created CIM Technology Center. It is strategically located in Stuttgart, in West Germany's high-tech heartland, close to neighbors which include Daimler Benz AG and major machine-tool makers.

Flexible manufacturing systems market



Europe absorbs a quarter of the world's sales of factory automation gear

Nixdorf's CIM tactics

Nixdorf is offering hardware from its minicomputer range, which includes the 8860, 8870, 8890 models and the Unix-based Targon. The German firm is also consolidating its CIM posture, thanks to a technological alliance to develop and market sophisticated software products with Cincom Systems Inc. of Cincinnati. Klaus Luft, Nixdorf's chairman says: "We are contributing our Unix-based relational database system. Cincom provides its own expertise in the same area as well as know-how in fourth-generation languages and CIM."

Bipe's Fremeaux comments: "The Europeans are resisting better in PLCs than in computers. The market is very open indeed. There's a big and growing market for everything that is electronically programmable." In industrial local area networks, young firms, such as France's Compex and Aptor, are showing annual growth of over 25% and are making good profits.

A stimulus to CIM in Europe comes from manufacturing automation protocol (MAP), the growing collection of rules and standards for electronics communication in the factory established by General Motors Corp. "MAP's progression over the past couple of years and its acceptance by European manufacturers have been an important spur to factory automation," says Texas Instrument's Emerson.

But putting the brakes on European CIM practice is the reluctance of small businesses to exploit its advantages. Sergio Mariotti, director of the Automation Process laboratory at Mip Politecnico, a high-tech college in Milan, Italy, says: "There is a major problem in persuading small- and middle-sized Italian companies to adopt flexible manufacturing systems. Big companies are much more willing to make the necessary investment because they are convinced that it will pay off. They also have more funds available."

A Tower of Babel of operating standards is also deterring top management in many European companies and handicapping the introduction of factory automation. "That is why Open System Interconnection (OSI) is so vital," says Emerson. The British Department of Trade and Industry has joined forces with manufacturers to promote OSI. Together, they have funded a communications standards center in Melton Mowbray, England. Ronald Armstrong, director general of PERA, an industry-funded management training school, who also carries responsibility for the center, says: "What is needed is a much-enhanced awareness at company board level of the competitive advantages of CIM when it is used correctly." □

THIRD IN A SERIES

U.S. electronics in Japanese cars? Not with *that* quality

When Honda, Nissan and the rest set up U.S. assembly plants, American electronics suppliers got excited. They needn't expect to get rich quick

BY NORM ALSTER

Snowballs in hell haven't fared much worse than U.S. suppliers of auto electronics in Tokyo. With Japanese automakers closely tied to a limited number of domestic suppliers, auto electronics has been one of the hardest of all hard sells for American businessmen in Japan. U.S. share of Japan's automotive electronics — and the broad auto parts — market has not even reached 1% in recent years, according to data from the U.S. Census Bureau.

But now there is at least some reason to believe that change is in the air. In the past 10 years, reports the U.S. General Accounting Office, Japanese carmakers have invested $5 billion in establishing U.S. auto assembly operations. By 1990, they are expected to produce 1.8 million cars annually in the United States. American Honda Motor Company Inc. and Nissan Motor Corporation U.S.A., the two largest and most entrenched Japanese transplant producers, both declare their intent to source the bulk of their supplies in the United States.

On the surface, then, it would seem that things can only get better for U.S. auto electronics suppliers. To some extent this is true. But for a variety of reasons, U.S. auto electronics manufacturers will not get rich quick on the transplants.

For one thing, the Japan-based auto electronics suppliers of Honda, Toyota Motor Corp. and Nissan have also begun to migrate to the United States. There are now, by most accounts, somewhere between 100 and 200 Japanese-affiliated auto parts suppliers in the United States, at least double the number of 1984. And their ranks will increase by more than 60% over the next four years, according to the management consulting firm of Easton Consultants Inc. These companies have relocated around the transplant auto maker hubs of Marysville, Ohio (Honda), Smyrna, Tenn., (Nissan), and Georgetown, Ky., (Toyota). They are intent on securing their ties with their traditional Japanese customers. They're also intent on expanding their business to supply General Motors Corp., Ford Motor Co., and Chrysler Corp.

Just as U.S. firms would like to crack the Japanese market, Japanese suppliers of semiconductors and such automotive electronic subsystems as engine controls, instrument clusters and audio systems are intent on selling to American automakers. And North America, quicker to set pollution standards and more partial to feature-rich luxury vehicles, is a much better auto electronics market than Japan. Cars sold in North America contained an average of $263 of nonentertainment electronics last year versus just $113 per car sold in the Asia Pacific region, according to Motorola Inc. "They're definitely looking at the U.S. market as a way to grow their business. And it's definitely a threat to us," reasons Michael Eisele, co-general manager of automotive operations for Intel Corp.

Another reason why Japanese auto-electronics suppliers are setting up shop in the States

It is clear, then, that the Japanese will try to sell here. But will the Japanese automakers and their subsystem suppliers actually buy here? On the surface, at least, the answer is yes. Honda and Nissan claim that they already do, domestically sourcing more than 60% of their parts. Honda, says vice president of purchasing David Nelson, will have 75% domestic content in its U.S.-built cars by 1991. Nissan vice president for engineering and purchasing Robert Drake claims 65% domestic content today and expects his Tennessee operations to be "near 80%" by 1990. Although Toyota and Mazda Motor refused to discuss their procurement policies with ELECTRONIC BUSINESS, the U.S. General Accounting Office reports that they too will be sourcing 60% or more of their parts domestically within the next few years.

This looks like good news for U.S. suppliers. But once again, appearances are deceiving. The Japanese are buying seat covers, tires, carpets and even fuel pumps and steel here. But very little electronics. Gregory Shepard, industry analyst with Dataquest Inc., reckons that "probably less than 10%" of the auto electronics used by the transplants is purchased from American suppliers. Robert Macosco, a principal with Easton Consultants, says electronics are "the last thing the Japanese are going to source here." The Japanese, explains Macosco, view electronic systems as "strategic" since they strongly influence vehicle "feel" and performance; in essence, the very personality of a car. Honda's Nelson concedes that domestic sourcing of electronics falls

well below the current 62% to 63% level for Honda's overall purchases.

There are other reasons the sourcing numbers are misleading. Nissan's Drake points out, for instance, that the vehicles made in Smyrna, Tenn., are low-end models with relatively insubstantial electronic content. Nissan's Tennessee operations, he says, simply don't buy much electronics. But even economy cars sold in the United States require engine control electronics to insure compliance with fuel efficiency and emission standards. Nissan's engine control modules, it turns out, are now being manufactured in Harrodsburg, Ky. The manufacturer is Hitachi Automotive Products. Nissan's domestic content figures count Hitachi as a domestic source.

Strategic and financial incentives

Japan's subsystem suppliers have ample motivation for establishing U.S. operations. Their chief customers benefit by their proximity and beef up their domestic content numbers. The subsystem suppliers can also market more aggressively to the U.S. Big Three: Hitachi's biggest customer has been Nissan but next year, the Kentucky operations claim the U.S. Big Three will absorb 60% of sales. And, of course, the weak dollar makes production in the United States economically feasible.

But the transplants get a good deal in the United States for other reasons too. According to Congresswoman Marcy Kaptur (D-Ohio), the Japanese have shrewdly availed themselves of foreign trade zones, originally established in the United States to encourage exports. By locating U.S. operations in foreign trade zones, Japanese firms can import components from Japan, assemble them in the United States, and pay duties on the assembled product only; a considerable savings over paying normal component duties. In essence, then, such operations make imported components cheaper. The use of foreign trade zone for importing automotive parts has risen tenfold, from $225 million in 1982 to $2.6 billion in 1986; and $3 billion for the first nine months of 1987, according to the International Trade Commission. Japan accounted for 70% of the 1986 total: a cool $1.8 billion in subsidized imports that support Japan's U.S. automotive assembly operations.

Honda's purchasing vice president David Nelson: The difference between required quality levels at Honda and the Western automotive world is "day and night"

The Japanese have also been encouraged by financial incentives from state governments in job-hungry Appalachian and midwestern states. Giant auto manufacturers have received giant state subsidies: Kentucky, for example, lured Toyota with $125 million in incentives. Now, the much smaller electronics transplants are being courted as well. Ohio awarded $8 million in relocation incentives to foreign suppliers during one recent 17 month period. Nippon Seiki, a leading supplier of dashboard electronics, established its New Sabina Industries in Sabina, Ohio. One reason was the $150,000 grant from the state of Ohio for on-site "infrastructure" improvements in water and sewer systems, New Sabina acknowledges. Another reason was the $100,000 grant to train new workers. Another $50,000 training sweetener is due this year.

With the logic and rewards of relocation so persuasive, the tide of Japanese suppliers will continue to redot the industrial maps of Kentucky, Tennessee, Ohio, Indiana and Michigan. It is inevitable, therefore, that as a rising economic force in the United States, the subsystem transplants represent a challenge to U.S. subsystem suppliers. But don't they also represent an opportunity to U.S. component firms? Where, in fact, are these makers of engine controls, dashboard electronics and auto radios buying their sensors, connectors and integrated circuits?

New Sabina tells much the same sourcing story as Honda, its major customer. According to president Yasuyuki Kobayashi, New Sabina sources 50% of its supplies in the United States. But to date, none of its electronics are bought here. New Sabina does appear to be trying, though, and has qualified two U.S. manufacturers of flexible printed circuit boards. And Kobayashi does confirm one of Honda's claims: that Honda wants its U.S. suppliers to buy U.S. parts. Although Honda has not ordered New Sabina to buy domesti-

D.R. Goff

cally, it has "encouraged" the use of American suppliers, according to Kobayashi.

Bernard Pierce, vice president for manufacturing at Alpine Electronics Manufacturing of America Inc. in Greenwood, Ind., says he too would like to use more American suppliers. But what does a leading Japanese audio electronics manufacturer do when stranded in the middle of the United States: a country whose consumer electronics industry it has helped to erase? With consumer electronics components as plentiful as needles in Indiana haystacks, Alpine shops its transistors, diodes and integrated circuits in the Far East. But Pierce says he is "getting familiar" with potential American suppliers and that U.S. electronics may be designed into future Alpine products.

An arduous process

For would-be suppliers of New Sabina, Alpine and other Japanese transplants it's simply going to take time. This, of course, is not a comforting message to companies that have cooled their heels for years in Tokyo. Intel, for example, has been trying to qualify as a Toyota supplier for more than eight years. For all its efforts with Toyota and others, Intel can claim just two Japanese designins: one for EPROMs packaged in the engine controls Hitachi sells to Nissan and another for a microcontroller used in a vehicle sold by Nissan in Japan. Still, Eisele and others believe that the Japanese are becoming more receptive.

"We see a definite interest that's increased rapidly in the last two years," he says. "They feel the overall pressure of the trade situation. In addition, over time they do want to become good local community companies with a local supply base." Eisele says after nearly a decade that produced just two design-ins, Intel is now "in the process" of qualifying for half a dozen new engine control and electronic braking applications with Japanese manufacturers.

"We have seen some customers taking a softer line," says Brad Marshall, vice president for sales for the semiconductor group at Sprague Electric Co. Marshall is hopeful of selling magnetic sensors for use in electronic braking, suspension and ignition systems to be built in 1991-1992 model year Japanese vehicles.

Japan's automakers have built U.S. facilities...

	Production start up	Annual capacity
Honda Marysville, Ohio	1982	360,000
Nissan Smyrna, Tenn.	1983	265,000
Toyota Georgetown, Ky.	1988	200,000
Mazda Flat Rock, Mich.	1987	240,000

Source: U.S. General Accounting Office

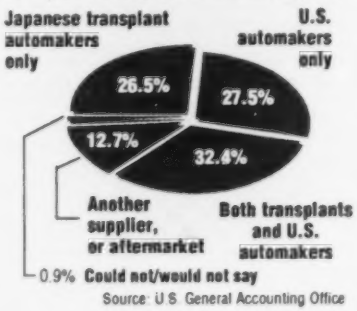
...but their Japanese electronics suppliers have tagged along...

	Date set up	Customers
Hitachi Harrodsburg, Ky.	1986	Nissan
Nippondenso Battle Creek, Mich.	1986	Mazda, Toyota
Nippon Seiki Sabina, Ohio	1987	Honda
Alpine Greenwood, Ind.	1987	Honda
Clarion Walton, Ky.	1987	Nissan

Sources: U.S. International Trade Commission, ELECTRONIC BUSINESS

...and some are winning U.S. automakers' business selling to:

Survey of 102 Japanese transplant suppliers



Source: U.S. General Accounting Office

It's hopeless trying to sell the Japanese technology that is only equal to what they can get in Japan, according to Marshall. But the Japanese "lag a bit in sensors," and therefore may be in a buying mood. Frederick Tucker, senior vice president and general manager of Motorola's Automotive and Industrial group, admits to about a year and a half of fruitless sales efforts in Japan. But Tucker is also optimistic about breaking through with sensors.

Many of the Japanese transplants do appear to be sincere in their desire to source domestically. Why, then, do things seem to move so slowly? Consider the difficulties in qualifying at Honda, by all accounts the most progressive of the Japanese carmakers. Honda purchasing honcho Nelson estimates that fewer than 5% of all U.S. applicants are qualified. And it's "not at all unusual," he adds, for qualification to take between a year and a year and a half.

Japanese viewpoint

Americans often take the painfully arduous qualification process as stonewalling. But from the Japanese viewpoint, it is necessary to ensure the quality and responsiveness they demand from their suppliers. And in fact, there are deeply ingrained traditions in Japanese auto making methodology that make it especially difficult for them to swiftly overhaul their supplier base.

The Japanese carmakers, for example, have historically maintained exceptionally close ties with a relatively small number of suppliers. Whereas Ford has 2,300 large volume suppliers, and General Motors 3,500, Japanese automakers generally deal directly with 200 to 300 suppliers, according to a 1987 study by the U.S. International Trade Commission. The Japanese often single-source and they source fewer components, relying far more heavily on integrated subassemblies. Japanese suppliers are under long-term contracts, are involved closely in design and development and are expected to respond quickly to a carmaker's request for product changes.

Companies like Toyota, one of the most diligent of all industrial implementers of just-in-time manufacturing, have historically encircled themselves with suppliers capable of providing frequent delivery and dedicated and timely support. All these factors make it difficult for U.S. hopefuls to crack such tight partnerships as Toyota-Nippondenso and Nissan-Hitachi, particularly as the subsystem vendors set up manufacturing to support their automaker partners in the United States.

But the major reason American electronics suppliers have had a tough time, the Japanese insist, is quality. American suppliers, they say, are simply not tough enough or dedi-

cated enough in meeting quality requirements. These claims must be taken seriously. There is simply no escaping the fact that Japanese automobiles (particularly those of Toyota and Honda) are significantly more reliable, as evidenced by the yearly frequency of repair ratings of *Consumer Reports Magazine*. The Japanese claim that this is no accident, that it is the result of exacting attention to detail; a discipline many U.S. suppliers simply refuse to respect.

"We find in most cases that the Japanese quality is better," insists Nissan's Drake. He allows that American quality has improved over the last two years. "But a lot of American companies don't feel that it's necessary to have every part in here that's good. If they've got a certain reject rate they think it's OK. The Japanese don't think that way. The Japanese think that every part — every one of them — should be good. We see American companies that think if they get 98% or 99% of them good, they're OK.... But that really upsets your whole system," moans Drake.

Voicing much the same sentiment is Honda's Nelson. Honda is actively looking for American suppliers, he says, but many of them don't take Honda's stated aims seriously enough. "We expect basically zero defects.... Our goal is to have four hours of inventory.... They think we're quoting from textbooks." Because American suppliers are somewhat lax, adds Nelson, "it's with great difficulty in almost every instance that we localize parts with an American source."

Although he declined to name the specific systems involved, Nelson says Honda sources electronic subsystems from United Technologies Corp. and TRW Inc. Nelson, who was director of purchasing for auto components, worldwide, at TRW before joining Honda, speaks with awe of the automaker's standards: "I am absolutely flabbergasted with the level of quality that's required at Honda in comparison to the Western automotive world. The difference is between day and night." Still, Nelson insists that once American suppliers understand the seriousness of Honda's quality and service requirements they can pass muster.

John Stark, vice president for purchasing with Delco Electronics, says differences between U.S. and Japanese quality have narrowed. Stark buys from both U.S. (Texas Instruments Inc., Motorola Inc., National Semiconductor Corp. and Intel, most notably) and Japanese (Hitachi Ltd. and Oki) manufacturers. "I don't think we see a lot of difference today," says Stark. "The field reliability — domestic and offshore — is very good." Dale Spoon, automotive operations manager for Texas Instruments, also contends that there is now little difference in the quality requirements of Japanese and U.S. auto customers.

Nissan purchasing vice president Robert Drake: "A lot of American companies don't feel that it's necessary to have every part good. The Japanese don't think that way"

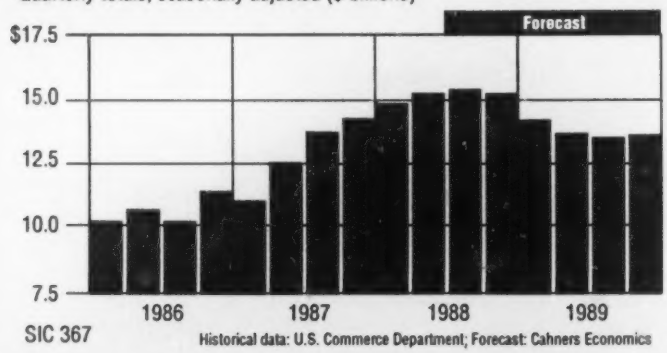
But Keith Casson, vice president with Sheldahl Corp., says Japanese customers have far more stringent qualification procedures. Casson should know, having just qualified as a vendor of flexible circuit boards to New Sabina Industries. "Yes, they have been more rigorous," says Casson of the Japanese. One test of flexible circuits, for example, involves folding and refolding the boards to see just how much crunching and creasing they can withstand. Japanese customers, he says, require "four times as many folds as the typical American company. Casson wonders whether the Japanese sometimes go overboard. "They have a tendency to demand more design safety or precision than their American counterparts, and possibly more than required."

Is U.S. quality really markedly inferior to Japanese? Or have U.S. manufacturers finally learned their lesson? Perhaps the most discriminating assessment comes from Masamitsu Okumura, president of Hitachi Automotive Products. He says that in Japan, most companies cluster closely in their quality capabilities. In the United States, however, "there is a wide range" of quality levels. "The best companies in the U.S. are very comparable to those in Japan," concludes Okumura. If this is the case, at least the best — and most patient — U.S. auto electronics suppliers should eventually stand to benefit from the transplants. □

Bob Schatz

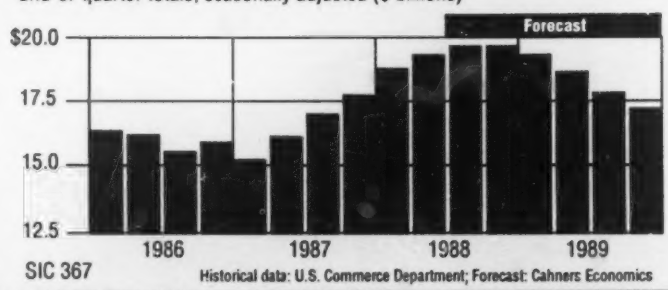
Electronic components — New orders

Quarterly totals, seasonally adjusted ($ billions)



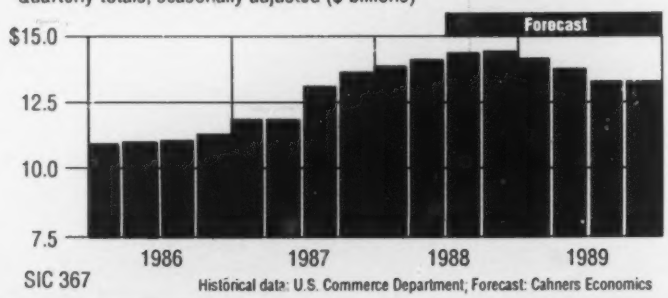
Electronic components — Unfilled orders

End-of-quarter totals, seasonally adjusted ($ billions)



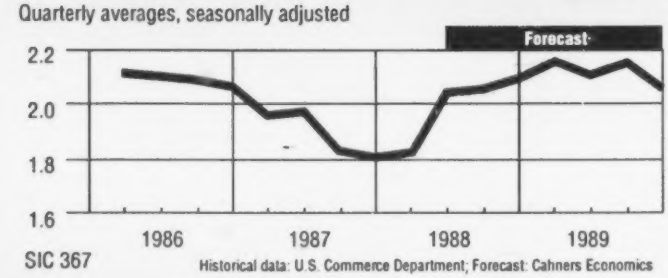
Electronic components — Shipments

Quarterly totals, seasonally adjusted ($ billions)



Electronic components — Inventory-to-shipments

Quarterly averages, seasonally adjusted



Component industry hits Lucky 13

After a long, depressing downturn in the mid-1980s, the current components recovery has been heartening. Still, many skeptics remain. After the layoffs and red ink of 1985 and the sluggish orders of 1986 and 1987, more electronics company managers are wary about late 1988 and 1989.

The latest data from the Commerce Department remains encouraging for 1988 at least. March marked an important event for the components industry: bookings outraced billings for the 13th consecutive month.

Comparisons

Not since 1983-1984, the industry's heyday, has the book-to-bill ratio remained so healthy for so long. Back then, more orders were booked than shipped for 17 months in a row. Comparisons between 1984 and 1988 help put the current economic recovery and possible 1989 downturn into perspective.

For instance, the book-to-bill ratio for the entire electronics component industry peaked at 1.31. That means bookings (new orders) were almost a third higher than billings (shipments). And the book-to-bill ratio back then often hit the 1.15 or higher mark.

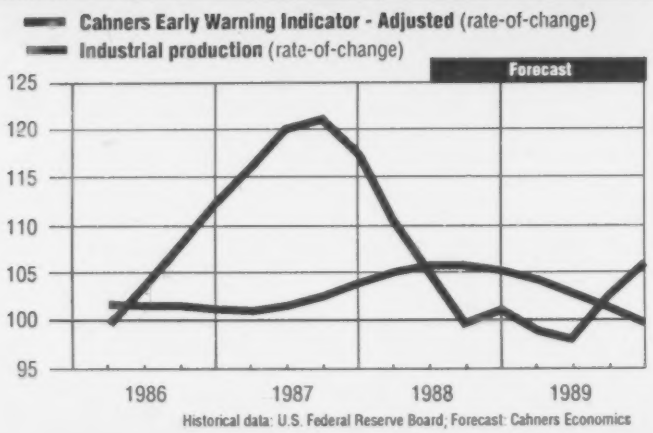
Now, in the past 13 months, the book-to-bill ratio has had trouble pushing past 1.10. This is not a bad sign. For an industry in which double- and triple-ordering caused a severe inventory crash in 1985, the current booking behavior is encouraging.

Coupled with relatively sedate new orders, inventory of components at U.S. factories remains extremely low. As of March 1988, inventories relative to shipments stood at 1.81. This number is meaningless unless it also is put into perspective. The lowest the inventory-to-shipments ratio has ever been is 1.76 (in December 1987 and January 1972). At the height of the 1985 debacle, the ratio stood above 2.30. So clearly, now inventories are being kept down.

All this data is telling the industry one thing: Don't worry. 1989 and 1990 are not going to be repeat years of the 1985 disaster. The inventory buildup and the over-booking which plagued manufacturers three years ago are nonexistent today.

Cahners Economics is forecasting a slight slowdown for the U.S. electronic component industry. Shipments from U.S. factories, which are expected to grow 14% this year, will see a 2% to 4% decline next year. This forecast is based on an overall economy-wide slowdown that assumes gross national product (GNP) will grow 3.1 in 1988 and 0.9% in 1989, after adjusting for price changes.

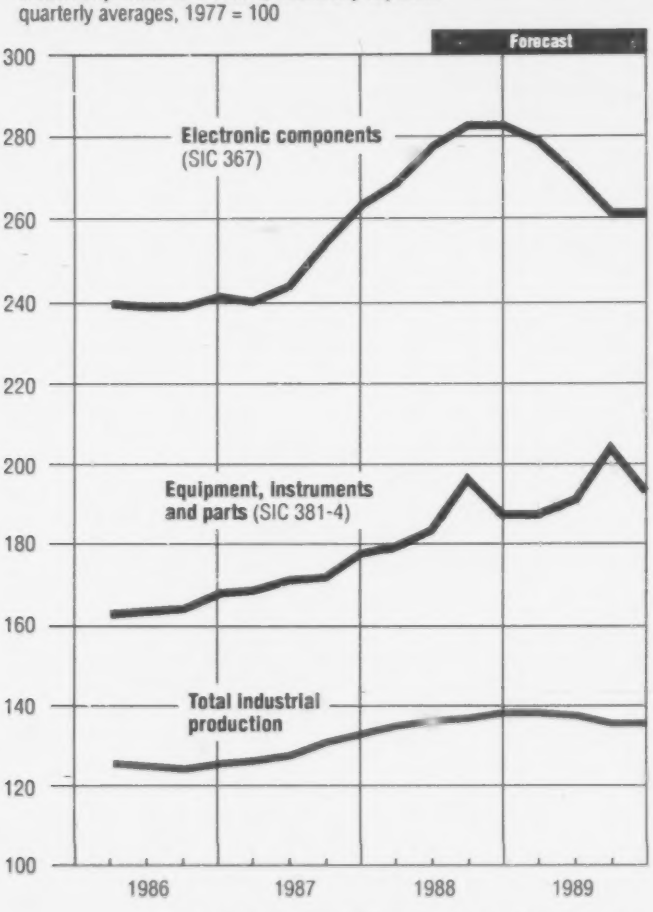
Economic indicators



Historical data: U.S. Federal Reserve Board; Forecast: Cahners Economics

Components and instruments — Industrial production

Industrial production indexes, seasonally adjusted quarterly averages, 1977 = 100



Historical data: U.S. Federal Reserve Board; Forecast: Cahners Economics

U.S. production remains steady

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Equipment industry: Steady as she goes

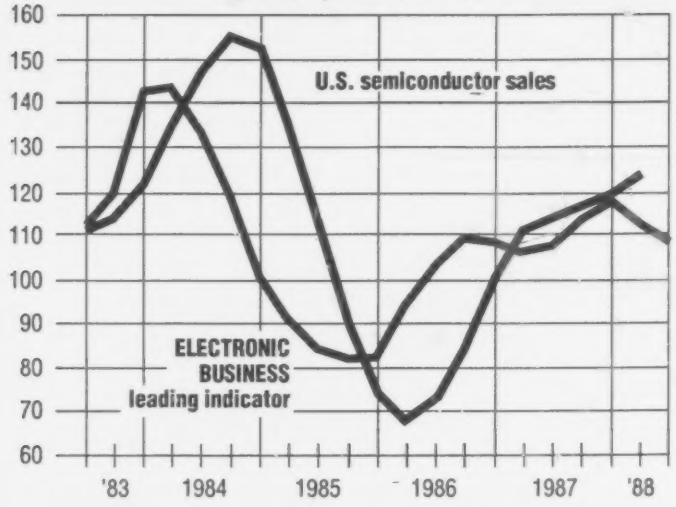
For forecasters, the equipment, instruments and parts industry has been like a dream. Quarter-to-quarter growth in this industry has been consistent, if somewhat unspectacular. Output at U.S. factories rose 0.8% in the first quarter of 1988 and will head up another 2% or so in the next quarter. Overall, Cahners Economics predicts an 8% gain for the entire year, almost twice as fast as last year. The best news for this industry is in 1989 and 1990. While many other electronics industries will be weakening, instruments, aided by the quality-conscious manufacturing sector, will be holding steady.

Components production nears 1984 records

U.S. factory output of electronic components rose 1.7% in the first quarter of 1988 and is estimated to have jumped 3.4% in the second quarter. As a result, production levels are now at their highest since early 1985. An 11% growth is forecast this year, followed by a 3.6% drop in 1989. Despite the 1988 growth outlook, production levels will remain just shy of 1984 records. But by 1990, due to such a mild 1989 downturn, records will be easily and quickly broken. Factory capacity will be at a premium, so equipment investment is not expected to fall much despite some end-market sluggishness.

ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368

Monthly (rate-of-change)

The ELECTRONIC BUSINESS leading indicator fell again in April to 109.5, the fourth consecutive monthly decline. The indicator will most likely continue falling for a few more months, possibly inching up one month occasionally. The overall trend will be a mild ratcheting downward, a pattern that will be typical in most electronics end markets in 1989.

Source: Cahners Economics

Electronics industry indicators this month

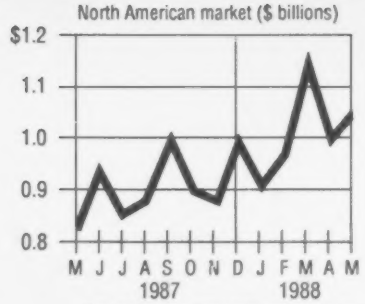
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, April)	109.5	111.0	107.4	111.8
U.S. semiconductor bookings ($ millions, 3-month average, May)	$1,223	$1,214	$1,025	$951
Weekly hours of semiconductor production workers (monthly average, April)	40.1	40.2	40.3	40.6
Electronic components leadtime index (1977 = 100, June)	120.2	114.3	90.1	100.7
Standard & Poor's semiconductor price index (1970 =10, monthly average, May)	58.2	60.1	69.7	65.5
Change in electronic components inventories ($ millions, SA, April)	+$36	+$33	-$8	+$47
Contract and orders for plant and equipment ($ billions, SA, April)	$36.9	$36.9	$33.3	$34.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

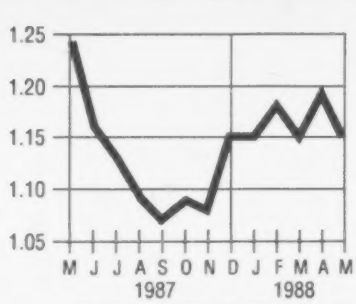
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

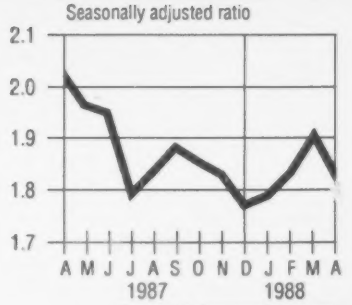
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 15, 1988

HIGH TECH IN CHINA

The new private sector

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Wan Runnan
president,
Stone Group

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 16 AUGUST 15, 1988

PAGE 28 Wan Runnan, China's Steve Wozniak

Cover Story/Asia Business

COMPUTERS

28 High tech in China: The new private sector

Wan Runnan is the Steve Wozniak of China. Like Wozniak, who cofounded Apple Computer Inc. in a garage in Silicon Valley, Wan, 42, also comes from humble origins. But instead of a garage, Wan and six friends from the Chinese Academy of Sciences founded his computer company, Stone, in a shabby two-room office on a commune in the western suburbs of Beijing. Today, four years later, Stone is the largest independent computer company in China.

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China is changing rapidly. Wan Runnan, cofounder of Stone Group, is emblematic of the shift toward private enterprise.

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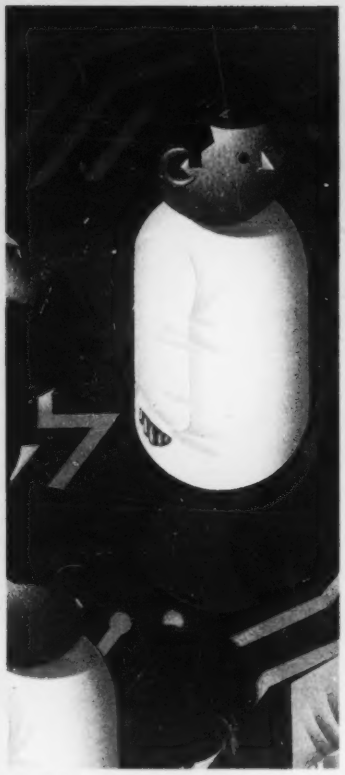

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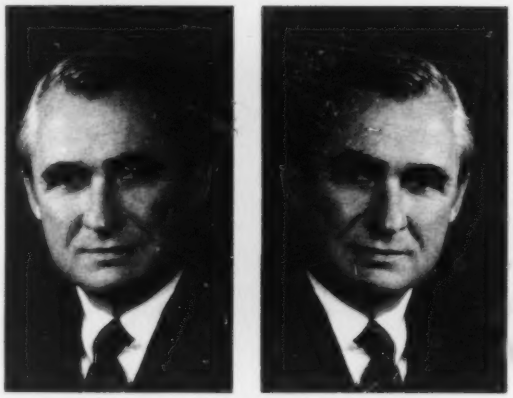
Parting is such sweet sorrow

Some people think that public relations departments play only a marginal role in the success or failure of a company. We disagree. In some cases, a company can live or die — depending on the quality of its in-house public relations.

Nobody know this better than the business press. We depend heavily on PR personnel to provide us with the access we need to the high-powered people who run the international electronics industry. In a sense, they are the gatekeepers to the industry — an awesome job, to say the least.



John Akers: This way . . . not that way

But sometimes, PR departments can take their jobs a little too seriously. Take IBM, for instance. Once again, IBM and its chairman, John Akers, swept into first place in our annual readers' poll of the best companies and best executives in the electronics industry. IBM and Akers took first place in two categories — mainframes and office computers.

To accompany our brief profile of IBM — and the 11 other winners in our poll — we called IBM's headquarters in Armonk, N.Y., and asked the public relations department for a photograph of Mr. Akers. The PR department graciously complied, but warned us not to reverse the negative. (In the publishing trade, when you're on deadline, it's easy to get harried and inadvertently flip-flop a piece of film.)

It seems that a well-known trade magazine, which shall remain nameless, once flip-flopped Akers' photo; and the chairman was not too pleased about it. "Mr. Akers parts his hair on the right," we were told by the PR department in no uncertain terms.

Now, IBM has a lot of friends in the business world. But it also has a lot of enemies. Maybe we're wrong, but one would think that IBM's PR department should be more concerned about improving the corporation's image in the marketplace, and less concerned about the photographic image of its boss.

Stalking the Feds

Speaking of IBM, one article in this issue which we strongly recommend is an analysis by John Dodge — a Boston area business writer — of Big Blue's thrust into the federal computer market.

IBM today owns about half the government personal computer market, but life may be different now that the company has unveiled its Personal System/2 family of PCs. Competition in the federal marketplace is more competitive today than it ever was. If you sell to, compete with or buy from IBM, we think you'll be interested in this article.

Intellectual property rights

Also featured in this issue is the first in a series on the strategic importance of defending your intellectual property rights. The series, which is being coordinated by managing editor John Kerr, offers contributions from several staff members, including Alden Hayashi, Anne Knowles and Valerie Rice.

AL FURST, Editor

Solid growth forecast for solid-state relays

Industrial automation and telecommunications are driving solid-state relay sales, which should top $244 million by 1991

The revitalization of American manufacturing may be having a trickle-down effect on the solid-state relay industry.

The U.S. market for solid-state relays — devices used to control motors, lamps and transformers, among other things — should nearly double in five years, predicts research firm Venture Development Corp. in Natick, Mass. Revenue for nonelectromechanical relays, including both solid-state and hybrid devices, will climb from $127 million in 1987 to $244 million in 1991, estimates VDC analyst Daniel Kennedy.

Several factors are driving this growth. Chief among them is probably the increase in industrial automation, which, in turn, fuels demand for controllers between factory machines and host computers. Other influences include the flood of new telecommunications products such as facsimile machines, computer modems and multiplexers, all of which require switching devices — relays commonly — to provide phone line access.

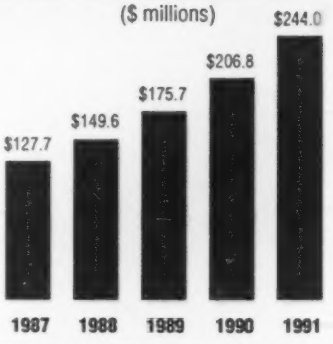
"The most significant part of our business is in input/output (I/O) modules for industrial automation equipment," says Robert Engman, president of Opto-22, a privately owned Huntington Beach, Calif., company and a leader in the field. Inexpensive personal computers have begun to replace programmable controllers as shop-floor brains for individual factory machines, he notes. Consequently, programmable relay modules have gained ground as they are increasingly being used as input/output devices to handle switching and communication between computers and machines.

"The main advantage of using relays on the factory floor is distributed intelligence," says Donald Long Jr., manager of the Florida Drum Co. plastics division in Pine Bluff, Ark. Long uses racks of Opto-22 relay modules to regulate process control and manufacturing equipment in the company's plastic drum plants. "We can have one computer controlling modules spread all over the plant," he says. "We could even use radio frequency modems to completely eliminate wiring." Before changing to PCs and relays, the company used programmable controllers permanently wired to individual machines.

In some cases, companies are bypassing I/O modules in favor of microelectronic relays. "Going to a simpler switch allows greater sensitivity and works well in noisy environments [prone to electromagnetic interference]," says Tom Cunneen, national sales manager for Theta-J Corp., a privately owned Wakefield, Mass., company specializing in microelectronic relays. In addition to factory floor applications, such relays are going into other kinds of industrial equipment such as gas pumps.

Nonetheless, says Engman, "we've seen a big increase in I/O modules in the last year or two," as companies ranging from industrial giants to small manufacturers raise their commitment to automation. He expects Opto-22 to generate more than $40 million in sales this year from a product line split almost evenly between low-power relays for printed circuit boards and heftier models for controlling larger-scale equipment.

Sales of U.S.-made relays



Figures are for nonelectromechanical relays, including solid-state and hybrid

Source: Venture Development Corp.

By and large, U.S. relay manufacturers are small or medium-sized privately owned companies. One notable exception is Eastman Kodak Co., which got into the relay business "by default," it says, because it couldn't find devices that fit the specifications for use in its own photocopying equipment. Another is Potter & Brumfield Inc., which was acquired several years ago by German electronics giant Siemens AG.

Prices are stable

"Prices have remained pretty stable for relays," says Darryl Bent, manager of Potter & Brumfield's solid-state product line. However, the company is bringing prices down, in some cases, by using contract manufacturing and by automating more of its own production facilities. "We're using more automation," he notes, "more automatic insertion, for example."

Other manufacturing trends include increased miniaturization. "We're trying to get more in less space," says Robert Ferran, vice president for marketing for Crydom Co. in El Segundo, Calif., the solid-state relay subsidiary of privately owned International Rectifier Corp. "We'll soon be introducing duals and quads — several relays in one hockey puck package," he adds, using the industry term for larger relays.

Another manufacturing trend is surface mounting of microcomponents — a technology that lends itself to more automated assembly. At Potter & Brumfield, for instance, the technology — which allows components to be inserted directly onto printed circuit boards — is rapidly gaining ground. "Now, 20% of our own products are produced with surface-mount technology internally; in a year, it will probably be 50%," states Bent.

Relay makers that specialize in microelectronic components are seeing demand start to grow for devices themselves suitable for surface mounting. "It hasn't been until the last year that we've seen customers actually go to surface mount," says Theta-J's Cunneen. "For now, it's mostly the biggest customers — they're the only ones who can afford it yet."

SARAH GLAZER

China is changing rapidly. Wan Runnan's Stone Group is emblematic of the shift toward private enterprise

High tech in China

The new private sector

BY AL FURST

Wan Runnan is the Steve Wozniak of China. Like Wozniak, who cofounded Apple Computer Inc. in a garage in Silicon Valley, Wan, 42, also comes from humble origins. But instead of a garage, Wan and six friends from the Chinese Academy of Sciences founded his computer company, Stone, in a shabby two-room office on a commune in the Western suburbs of Beijing.

Today, four years later, Stone is the largest independent computer company in China. Staffed by 700 employees, it manufactures and resells a wide variety of computers, peripherals, and electronic typewriters which can produce Roman characters on one setting and Chinese characters on another. It also claims 80% of the domestic market for software used in Chinese character processing — the equivalent to our word processing.

Success has come swiftly to Wan. In 1987, the privately held company — renamed Beijing Stone Group Corp. — had about $9 million in after-tax income on $137 million in sales, a fortune in a country where the average peasant earns $300 a year.

More importantly, Stone — one of the first privately held high-tech companies in China — has come to symbolize the increasing importance of free enterprise principles in what was once a wholly planned economy. While state-run enterprises account for 93% of China's $2.36 billion in computer production, and that percentage is not likely to decrease very much in the next decade, reformers in the government realize that they badly need to emulate Wan's entrepeneurial skills if China is going to be able to successfully-industrialize.

Risk-taker

Wan is a risk-taker in a society that doesn't like to take risks; a go-getter in an economy that sometimes seems like it's going nowhere; and an iconoclast in a country that refuses to break with its 5,000-year feudal tradition of regional bureaucracies. Because of this, Western multinationals say the emergence of Stone — and of private companies like Stone — bodes well for those who wish to do business in China. If Stone can succeed in China's byzantine commercial marketplace, then there's hope for American, European and Japanese firms.

There's also hope for China's domestic computer industry. In Beijing alone, there are now over 170 privately held high-tech companies operating on Zhongguancun, or "Electronics Street." And more privately

Using $5,000 in borrowed capital, Wan Runnan launched his company in 1984. Today it has sales of $137 million

held companies are springing up daily in other parts of China.

"In part, what we're seeing now is a real shift in the locus of technological development and dynamism, away from the bureaucratic, [state-run], traditionally administered research institutes," notes veteran China watcher Denis F. Simon, an associate professor of international business relations at the Tufts University Fletcher School of Law and Diplomacy. "The trend instead is more towards high-tech oriented companies, something akin to joint stockholding companies. These companies are outside the stranglehold of the Chinese bureaucratic organizations. They are keenly aware of technological developments outside of China, and they are trying to plug into them. And they are more attuned to market dynamics, including maintenance, service, quality and product differentiation."

Stone's contribution to the Chinese economy has not been lost on the Chinese either. In the past year, Wan, who quit his job in 1984 as the director of the Computing Center at the Chinese Academy of Sciences to launch Stone with $5,000 in borrowed funds, has joined the pantheon of new economic heros in China. He is lionized in the press. He is wined and dined by high-ranking Communists. He lectures at universities.

Management skills

Economic reformers in the government — who hope China can become a world power in consumer electronics by the year 2000 — believe entrepreneurs like Wan Runnan can provide the Chinese computer industry with badly needed management skills.

China has always been strong in basic research and development. It is applied R&D, the transfer of technology from the laboratory to the factory floor, where China falters. That may be one reason why the government is encouraging the public sector to emulate Wan's approach.

The only problem is that Wan's marketing savvy may be difficult to duplicate. In many respects, Stone's success story is a unique phenomenon. Realizing in the mid-1980s that the IBM Personal Computer was fast becoming the de facto PC standard in China, Wan struck a deal to import Japanese printers and typewriters which he redesigned to make them more adept at handling Chinese ideograms. Later, he arranged for Mitsui Co., the Japanese trading company, to build the printer under license, and Stone exported 10,000 of them to China at $500 apiece. Previously, the company had purchased printers at $1,400 apiece from Toshiba Corp.

Later, after a field trip to the United States, he branched off into electronic typewriters and computers — again specializing in products that could be specially tailored to the Chinese market. Now Wan, as president of the firm, operates a slew of subsidiaries — including a joint venture with Mitsui to manufacture Chinese-English electronic typewriters and a division in Shenzhen, a free trade zone near Hong Kong, which is run by his wife, Li Yu, a software engineer and a company vice president. Stone's other subsidiaries sell everything from test equipment to power supplies.

If Stone can succeed in China, then there's also hope for Western high-tech firms

The difference between Stone and the public sector, however, is like the difference between an automobile and an ox cart — which is still, incidentally, the main mode of transportation for some provincial high-tech companies. Like all Communist countries, China is state-run. A complex web of ministries and other government agencies sets priorities, establishes production quotas and tries to regulate demand. To ensure that the system works, everyone is guaranteed work. This is the so-called "communal rice pot" — out of which everyone eats — or, as it is more frequently known, the "iron rice bowl." Everyone in China is guaranteed a job, no matter how talented or ill-equipped they are to hold it; and everyone earns roughly the same wages, no matter how hard they work, or don't work, as the case may be. Naturally, with such disincentives for individual initiative, lethargy and bureaucratic wrangling has become a way in most state-run enterprises.

Along comes Wan

Then along comes Wan. One of the first things Wan did when he moved into a renovated five-story building on Zhongguancun, was put up a sign in the lobby: "Replace the iron rice bowl with a clay rice bowl." "The clay rice bowl is stronger than the iron one," Wan says, "but it can also break more easily. That is the risk factor." Without risk there is no profit.

In Wan's operation, managers and employees who do not perform up to company standards are terminated — until recently, an unheard-of concept in China. Those who do perform are rated by their performance and paid accordingly. Some employees can earn 10 times as much as others on the payroll. Moreover, the wages he pays — $32 a month for clerical staff to $108 a month for Ph.D.s —

Top 10 computer companies in China

1987 sales ($ millions)

1.	**Stone Group**	$137.1
2.	**China Computer Development Corp.**	$101.8
3.	**China Computer Technology Service**	$43.9
4.	**734 Factory - Electronics Ministry**	$42.9
5.	**738 Factory - Electronics Ministry**	$26.3
6.	**45701 Factory - Electronics Ministry**	$26.0
7.	**Shanghai Computer**	$22.7
8.	**Beijing Xintong Computer Technology**	$20.5
9.	**South China Computer**	$16.5
	Shandong Computer Service	$16.5
10.	**Fujian Computer**	$14.7

Source: *Computer Information*

are about twice the average wage in China. In an egalitarian society like China, this approach is positively revolutionary — or reactionary, depending on your politics.

Nevertheless, Wan's "contract" system — which has been endorsed by Communist Party General Secretary Zhao Ziyang and others in the highest levels of the Chinese goverment — does seem to be paying dividends. Wan says the firm earned $9.6 million last year, making it one of the more profitable firms in a desktop computer industry plagued by overcapacity at the low end.

But perhaps more importantly, the system is proving to be extremely productive. In 1987, top-ranked Stone had $205,000 in sales per employee, about twice the norm for the top 200 electronics companies in the United States and perhaps eight to 10 times higher than the productivity at many state-run Chinese electronics companies.

"We'll use 50% of our profit for further product development," Wan says. About 30% will go for medical and welfare benefits, including housing — which Stone must partly subsidize if it wants to lure capable workers away from state-run enterprises. (To this end, Wan is currently setting up a real estate division inside the company.) The remainder goes into the "bonus" pool.

Wan has also set up a pension plan for his employees. Retirement for males is 60 years of age; for women, 55. According to Wan, the benefits are "higher than those paid by state-run enterprises." But because Stone's future is riskier than that of his counterparts in the public, he also provides his employees with insurance — in the event he has to lay off some of his employees because of market conditions. That's not even a problem at state-run factories which are virtually guaranteed survival by the government, no matter how badly they perform. That may change if China ever enacts a national bankruptcy law, but for the time being, the public sector is still a much more secure place to work than the private one.

To the rescue

Fortunately for China, though, the public sector is getting more and more insecure every day. The winds of change are sweeping through the Chinese bureaucracy. In a controversial move, the Ministry of Electronics Industry, the main high-tech power base in China, merged this year with the Ministry of Machine Tool Building, the main power base for industrial manufacturing, and 1,000 state jobs were eliminated at the state level.

Nevertheless, resistance to change remains endemic. Although Stone is publicly applauded as a symbol of the new China, many bureaucrats at state-run computer enterprises are reportedly bitter about Wan's success. "They claim it's my fault that nobody wants to buy their products," Wan says. "They would prefer it if I sold lower quality products at higher prices."

Economic reformers hope Wan can provide China with badly needed economic skills

The state-run Science and Technology Printing Institute also recently made noises about suing Stone, which had recruited some its scientists, for alleged patent infringement — a charge that Wan denies

High-ranking government officials, however, are clearly on Wan's side. Earlier this year, the Yunnan Electronic Euipment Factory in southwestern China, a state-owned microcomputer plant that was in deep financial trouble, signed an agreement whereby Stone would take over the management and marketing functions of the factory. Among other products, the Yunnan plant manufactures B-25 workstations under contract to Unysis Corp. for the Chinese banking industry. The first thing Wan did, he recalls, was "break the iron rice bowl" by firing 50 workers and reorganizing the management structure of the plant. Today, he says, it's well on its way of meeting its revenue target of $27 million, double that of the previous year. "Wan is already having a very positive impact on our business," says Jean-Jaques Reymond, director of market development for the Pacific/Asia Division at Unisys.

Under the terms of the agreement, Stone is also eligible to acquire up to 10% of the firm's assets by reinvesting profits into Yunnan Electric over a five-year period.

Recently, Stone also struck a simi-

Welcome to Electronics Street

Just as Silicon Valley had its origins in Stanford University and Route 128 in the Massachusetts Institute of Technology, Zhongguancun, or "Electronics Street," is an outgrowth of Beijing's nearby Academy of Sciences, home for 80,000 of the nation's top researchers.

Former electronics vice minister Xie Gaojue says the district will get special treatment

On the street in Western Beijing are more than 170 high-tech companies, including Stone Group. Once viewed as a fringe area of the city — with possibly a flourishing illegal black market in computer chips — the district is now highly respectable.

This winter, then-Premier Zhao Ziyang even put the official state imprimatur on Zhongguancun by making a highly publicized visit to the district. Later, the Beijing Muncipal Goverment set up a special economic zone there, complete with special tax incentives for companies involved in the development of new technology.

"Areas like these will always enjoy preferential treatment," says Xie Gaojue, formerly a vice minister of the Chinese electronics industry. To date, 400 new firms have applied for licenses to set up shop in the zone. The city expects to receive about 1,000 applications by year-end. □

lar deal with the Institute of Machinery Manufacturing Technology in Shanghai, a powerful and innovative research institute and prototype manufacturing plant which was very strong in technology but weak in both management and marketing. The Institute produces excellent computers but sources say much of the product winds up sitting in warehouses because of the Institute's inability to properly market the hardware.

Meanwhile, Wan continues to cast around for new market opportunies. Recently, he opened a company in Hong Kong which includes a department for product development. Next year, for the first time, Wan plans to market some of his products in North America. And he's even looking at the possibility of opening a company in the United States. His goals are modest — about $5 million in sales — but if he succeeds, he will be one of the first Chinese computer manufacturers to sell product in America.

It will not be easy, but Wan — who works 80 hours a week, sees his son in Shenzhen once a week, and spends his spare moments playing bridge or watching sports programs on TV —is used to new challenges. Wan says that one of the reasons he named his company Stone was because he liked the sound of the English word and because there is a peasant saying in China which captures the spirit of his enterprise. "When you go out into the dark night," Wan says, "the first thing you must do is throw out a stone to see where the road is." □

Tips on doing business in China

Reto Braun, president of the Pacific/Asia Division of Unisys Corp., which currently works with Stone Group to manufacture B-25 workstations at the Yunnan Electronic Equipment Factory in southwest China, offers the following advice to U.S. high-tech companies doing business in China:

First, a high-tech firm has to recognize it is likely to be dealing with a lower level of customer knowledge than in a consumer business, for example. In fact, it will often find itself marketing complex products to inexperienced customers through experienced third parties.

This leads to the **second** point. A high-tech firm is often confronted with a desire for higher level technology than is needed, higher than can be operated and maintained adequately and higher than can readily be cleared through the export licensing procedures.

A companion **third** point: High-tech firms will find the Chinese expecting to save money, particularly foreign exchange, on maintenance costs. They'll want to do maintenance themselves, often without adequate experience or appreciation of the magnitude of the task. This is a great concern for firms which must energetically protect the reputation of their products for performance in the field.

Fourth, the rapid change of regulations relating to importable levels of technology, duties and taxes is likely to have greater impact on a high-tech enterprise. There is a high capital-to-labor investment ratio in China and a need to amortize expensive tooling and training. Stability in the market conditions may be more important.

Fifth, communications is a special concern for high-tech enterprises. The complexity of products or manufacturing processes puts a high premium on good understanding and rapid, direct interaction — at all points — language comprehension, physical facilities and effective training.

Reto Braun of Unisys

Sixth: For firms selling major high-tech systems into the PRC, it is important to educate the Chinese to the need for systems studies before making commitments to complex installations. Only a few people in China yet recognize that they must face up to the cost of contracting outside expertise to make such studies. Know-how to optimize systems is at least as important as buying hardware.

Seventh, high-tech activity brings with it an extra measure of bureaucratic complexity on both sides of the Pacific Ocean. On the Chinese side, there are additional agencies concerned to supervise and monitor and coordinate and clear. On the U.S. side, there is the control of advanced technology in the interests of national security. Knowledge of this bureaucracy is mandatory.

As the experience of Unisys and other companies has shown, it is definitely possible to succeed in China today. However, it is a most difficult challenge. It requires great commitment and patience — even though a reasonable business return cannot be deferred forever in pursuit of a great and distant potential. Companies are not governments. The Chinese government must accept the necessity of establishing and maintaining conditions that recognize the legitimacy of a reasonable business return and permit such a return to be earned.

And finally, **eighth**, I would like to make several specific suggestions which experience suggests could be useful to each side as a practical road map:

- Go for a level of technology which is proven. Proven does not mean obsolete. Proven technology is state-of-the-art technology. It must be technology that can be assimilated by the Chinese side, and which is licensable by the United States or another Western country.
- Next, I suggest that one check early with Washington, or your own national licensing board authorities, to verify the licensable level of exports.
- Then prepare to put special effort into education at all points with your Chinese collaborators and their market. This effort should cover the product, its assembly or manufacture, quality assurance, its selling strategy and field marketing, and maintenance. □

America's electronics sector is putting a new value on its patents and copyrights. It's not just a job for the lawyers — it's management's priority too

Management's new cry: Fight for your technology rights!

BY JOHN KERR

You've just spent your life savings and a decade developing the Wonder-Chip, an outstandingly novel microprocessor that tests itself, repairs itself, resists nuclear radiation and handles trillions of instructions per second. The military and the big computer makers are beating a path to your door, and the OEM orders are flooding in. Drinks all around.

But suddenly you're not buying anymore. You've just gotten word that you're being sued for patent infringement by one of Japan's largest chip makers.

Welcome to the real world — a world where protection of intellectual property has become a distinct strategy for top management in the electronics industry. Where lawsuits fly thicker than ever and senior executives worry about their intellectual property walking out in the heads of their top designers. Where foreign firms pirate U.S. technology without shame. Where Japan fiercely protects its own technical rights. And where, some say, litigation is used as a marketing tool.

We're not talking about pennies here. In 1986 — the last year for which information is available — a sample of 48 U.S. computer, software and electronics companies reported losses of $6.5 billion in revenue as a result of intellectual property infringement, according to market researcher Dataquest Inc. That's an average loss of $135 million per company.

While legal maneuverings over software copyrights have made most of the headlines — and will continue to do so as firms increasingly file for patent protection instead of copyright — there is also furious activity in defense of hardware rights.

Protection of the collage of patents, trademarks, copyrights and other legal tools with which a company attempts to defend its technology is central to the philosophy of many senior electronics executives. "It's a key requirement for success — as long as it's used right and on a timely basis," says Philip White, president of PC and terminals maker Wyse Technology of San Jose.

Hitachi's No. 1

That message has not been lost on the Japanese. Witness the change in the rankings of the top 10 corporate holders of U.S. patents: in 1975, the top three were General Electric Co., E.I. du Pont de Nemours & Co. and Westinghouse Electric Corp. In 1986, reports the U.S. Patent and Trademark Office, Hitachi Ltd. topped the list, ahead of GE, which led Toshiba Corp. by a whisker.

Higher visibility for intellectual property protection is manifest in the surge of business seen by both independent and in-house patent attorneys: San Francisco law firm Limbach, Limbach & Sutton has expanded from two lawyers in 1968 to 30 now, largely on the strength of Silicon Valley's concern over property rights. Wyse, for instance, is utilizing more outside counsel than ever. Peripherals-products maker Western Digital Corp. of Irvine, Calif., is trying to recruit an in-house patent lawyer.

And this trend is evident in the upsurge in patent judgment appeals passed on by U.S. district courts to the U.S. Court of Appeals, Federal Circuit (CAFC), in Washington: up from 172 in 1983 to 246 in 1987.

A sound strategy for property rights defense involves decisions on everything from filing in the countries where it will do the most good to laying out trade secrets guidelines that help keep key employees; from tactics for boosting short-term income from licensing fees to pushing patents on software. It means knowing when to push and when to negotiate, what to second source, and where.

It has been that way for decades in the pharmaceutical and chemical industries. Electronics giants like IBM and General Electric Co. have been able practitioners for at least as long. "We've always considered intellectual property to be important," says Jan Jancin, a counsel on intellectual property law at Big Blue's corporate headquarters in Armonk,

PART I: THE PROBLEM

As U.S. firms struggle to remain competitive, intellectual property protection has become a critical concern. This overview is the first in a three-part series on the problems of technology loss — and the solutions. Subsequent issues of ELECTRONIC BUSINESS *will detail how some companies are overcoming these problems and also provide expert advice on how you, too, can keep control of your technology.*

N.Y. But only in the past few years has the issue received star billing in the electronics industry at large.

The degree of concern varies from industry sector to sector: in desktop computer microcode, for example, the issue is white hot; in disk drives, where an electromechanical bias prevails, it's less so. That is changing, however, as drives take on more intelligence. "We haven't done as good a job of patenting some things as we should have," confesses Finis Conner, CEO of 2-year-old drive maker Conner Peripherals Inc. of San Jose.

Others have neglected to renew patents, or ignored technology that might have applications in future corporate moves. Some show ignorance of foreign rules; for example, filing patents in Japan without planning to market there near term. That way, they leave themselves open to trespass when, under Japanese law, the patent is opened to public scrutiny after 18 months if not awarded by then. And still others wrongly view intellectual property protection as a one-off operation instead of an ongoing strategy.

Small firms wise up

But even the smaller electronics firms are wising up. A recent survey by ELECTRONIC BUSINESS of companies in this category — 91% with annual revenue below $10 million — shows strong awareness of and interest in protection of intellectual property.

In a telephone poll of 100 senior executives, 93 of whom are presidents of their firms, only 6% said that they were suing to protect their technology. But 58% claimed to be bringing more of their engineering work in house, while 36% said they were reducing second-sourcing agreements for fear of technology leaks. And 71% reported that they were providing extra incentives to retain key technology employees. Only 10% admitted that they were doing nothing to protect their intellectual property.

It wasn't that nobody cared about their technology before the 1980s. It was simply that it wasn't perceived as the most pressing issue. But a rapidly shifting business environment is forcing that notion to change. William Keefauver, an AT&T vice president and the company's top lawyer, cites three reasons: a significant gain in the competitiveness of foreign nations, coupled with an upsurge in counterfeiting; a higher proportion of a vendor's added value found in software; and a radical ruling in 1982 that created the CAFC — a body that has consistently upheld the value of patents.

Patents didn't count for much prior to that; as much as 70% of all patents were found to be invalid when tested in court, largely because the courts ruled in favor of dissemination of technology. "During the 1960s and 1970s, the concern was over monopolies. But that concern has largely disappeared," explains Oliver Smoot, executive vice president of the Computer and Business Equipment Manufacturers' Association.

Hence, the spirited patent defenses mounted in recent years: Texas Instruments Inc. vs. eight Japanese and Korean chip makers over DRAM patents; Cipher Data Products Inc. vs. Wangtek Inc. over the 5.25-inch form factor for quarter-inch tape drives; IBM head-to-head with Nashua Corp. over floppy disk patents.

The story's much the same in the copyright arena. Fujitsu Ltd. lost out to IBM over operating-system software copyrights. Intel Corp. and NEC Corp. are presently locking

Terry Widener

horns over semiconductor microcode. And Apple Computer Inc. is suing Hewlett-Packard Co. *and* Microsoft Corp. over its rights to full copyright authority on windowing software.

It's evidently worth it to many. Last year alone, Texas Instruments garnered $191 million in settlement costs from the Far Eastern dynamic RAM makers. And when Polaroid Corp. sued Eastman Kodak Co. for $5.7 billion over the rights to make and sell instant cameras, eyebrows climbed foreheads. "That showed you could lose a ton of money and market share if you didn't care too much about your intellectual property," reports AT&T's Keefauver.

The courts are not the only method being used to hash things out. Many companies are using independent arbitrators; others find use for mediators not unlike those used in labor versus management wage disputes.

IBM gets tough

The pace of intellectual property protection is hardly slowing. Indeed, quite the reverse appears to be true. "The patent budgets of several of my clients are up significantly," reports David Lovejoy, partner at San Francisco law firm Fliesler Dubb Meyer & Lovejoy. And just look at what Big Blue is up to. IBM doesn't put it in these terms, but it has by any measure become much more aggressive in going after what it believes it is due. In May, it began demanding that PC clone makers pay retroactive licensing fees. This, after its April increase in licensing fees on its worldwide portfolio of 32,000 patents.

Under the new rates, licensees still pay 1% tops on sales revenue on a product using a single IBM patent. But since April 8, they've felt the bite as the previous maximum 1% rate for multiple and varied patent use has swollen to 5%. "This better reflects the value of that technology to licensees, and put IBM more in line with other companies," explains a spokesman.

If anyone still doubts that intellectual property protection is not for Mahogany Row, hear this: IBM chairman John Akers was instrumental in the decision to hike royalty rates. IBM has even warned competitors that it considers RISC technology to be IBM technology. Rivals not paying royalties could be infringing on IBM patents, according to company.

IBM adamantly refuses to disclose how much more it will glean from its move to increase revenue by licensing all its technology. But it will clearly run into millions of dollars annually. RCA Corp., now part of GE, holds over 1,000 patents in video technology and derives from them $150 million in yearly royalties.

However, not many companies admit to developing patent portfolios solely to generate revenue. "We don't do it to make money," remarks Wyse's White. Adds Conner of Conner Peripherals: "Patents to me are more for negotiating purposes than for revenue streams."

Cross licensing of technology is a favorite tactic of those with fat patent portfolios. And it's as good a reason as any for building up such a portfolio. "Our strategy is to build up a decent patent portfolio," claims Irwin Kwatek, vice president and general counsel for Western Digital. The more patents you have, he reasons, the more easily you can deter those threatening trespass on your technological turf. And the more you can trade technology without having to reinvent wheels.

Western Digital's strategy involves a program to encourage engineers to patent their inventions. Half of a $4,000 award is handed out when a patent is applied for, the other half a year or two later when the patent is granted.

Gallium-arsenide chip maker Triquint Semiconductor — a Beaverton, Oregon-based spin-off of Tektronix Inc. — also wants to build up a patent portfolio, but president Alan Patz doesn't hold with cash incentives be-

Legal-speak: A glossary of intellectual property jargon

- **Intellectual property**: Copyrights, patents, trademarks, trade secrets, semiconductor mask works, proprietary technical data, and other proprietary (and often intangible) entities to which companies have unrestricted and exclusive rights of ownership.

- **Trademark**: Any word, name, symbol or device, or any combination thereof, adopted and used by manufacturers or merchants to identify their goods and distinguish them from those manufactured by others.

- **Copyright**: Protection provided by a national government to authors of original works. The owner of copyright has the exclusive right to reproduce the copyrighted work; prepare derivative works; and distribute copies.

- **Patent**: A grant issued by a national government conferring the right to exclude others from making, using or selling the invention within the national territory. (One kind — utility patents — are what IBM licensed with its PS/2 to cover functions or processes, but not specific designs.)

- **Trade secret**: Information, including a formula, pattern, compilation, program, device, method, technique or process, that derives independent economic value (actual or potential) from not being generally known, and is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.

- **Semiconductor mask work**: A series of related images, however fixed or encoded, having or representing the predetermined, three-dimensional pattern of metallic, insulating, or semiconductor material present or removed from the layers of a semiconductor chip.

- **Proprietary technical data**: Data submitted to a government agency in connection with the regulatory review of a product.

- **Source**: U.S. International Trade Commission report on "Foreign Protection of Intellectual Property Rights and the Effect on U.S. Industry and Trade" and "Intellectual Property Rights: Global Consensus, Global Conflict" (Westview Press, 1988).

M.J. FOLEY

cause he believes that's a quick way to end up with technology that isn't easily commercialized — or licensed. But he did, soon after Triquint's inception, put in place a definite strategy for protection of intellectual property. "We made a decision very early on that we had to have it," he says.

Implementation of that strategy has meant formulation of a framework for teaching key supervisors the procedures for filing patents, the types of inventions that patents can be filed on and the technologies that Triquint will keep as trade secrets.

United States patent applications filed by residents of foreign countries

Residence	1984	1985	1986	1987
Britain	4,482	4,473	4,862	5,173
Canada	2,539	2,570	2,700	3,072
France	3,481	3,801	4,032	4,069
Italy	1,802	1,799	1,879	2,054
Japan	18,289	21,669	23,491	25,022
Netherlands	1,227	1,336	1,350	1,410
Sweden	1,408	1,429	1,407	1,311
Switzerland	1,843	1,966	2,021	1,975
West Germany	9,551	10,722	10,630	10,951

Source: U.S. Department of Commerce

Japan and Germany continue to dominate the list of foreign patent holders

Too aggressive?

Strategy or not, there are those who question the rightness of the new aggression in protecting a company's technology rights. "Many people feel that Apple is going way too far," claims LeRoy Rahn, a partner at Pasadena, Calif., law firm Christie, Parker & Hale, in reference to Apple's feud with HP.

There's a sense that all that time spent in court — or in arbitration — is time and energy that could better be spent in advancing the company in other ways. An engineer's time spent agonizing over whether his or her design might infringe on someone else's technology is not as productive as it might be.

There's also a sentiment that perhaps some of the larger companies are going too far. One small California peripheral maker, sued by Digital Equipment Corp. for an alleged technology infringement, told ELECTRONIC BUSINESS that it believed that DEC was using litigation as a marketing tool, the implication being that the longer DEC could stall the little company's products, the sooner it could get its own to market. DEC denied the charges.

Other observers maintain that courtroom tactics are sometimes battles for honor and sometimes publicity stunts. At the least, they indicate, the suits are a means of putting the brakes on the competition.

Blood lust

So, have large electronics companies acquired a blood lust? And do they have an advantage over smaller firms when it comes to protecting their intellectual property? The jury's still out on that one — and will remain so. "The larger companies have the money and the lawyers to protect themselves during legal battles," says one respondent to ELECTRONIC BUSINESS' poll of small firms; "The large companies are already in partnership with the foreign pirates," snipes another. At issue is the well-being of the small companies that are acknowledged to be the wellspring of technological innovation in America.

But other respondents agree that the large firms have more to lose, the corollary being that small companies can lie low. That's been true for Tustin, California-based chip maker Silicon Systems Inc., which this year will

The perils of second sourcing

As manufacturers get caught up in the heat of intellectual property protection, second sourcing — once an industry standard — seems to be falling from favor. "Too much second sourcing is not a good thing," says Thomas Dunlap, vice president and general counsel for Intel Corp.

Intel recently announced that its new embedded control products would not be second sourced. Intel's not saying whether the decision was made because it was burned by two now-sour relationships with NEC Corp. and Advanced Micro Devices Inc., or simply because it doesn't need a partner.

But, clearly there is a trend away from second sourcing. "There has been a drop-off in second-sourcing agreements," notes Dataquest Inc. senior analyst Alice Leeper. A recent survey by ELECTRONIC BUSINESS confirms that many companies are cutting back on second-sourcing deals for fear of technology leaks.

"Most of the hot [microprocessor] products right now don't have second sources," adds Leeper. The ones that do are from the new companies like Sun [Microsystems Inc.] and MIPS [Computer Systems Inc.], because they have new technologies that need to be established." Large companies, it appears, can forego second sourcing, while smaller companies must risk losing intellectual property rights to survive.

Yet, second sourcing will continue. Even some large companies, notably NEC and AMD, continue to champion the need for second sourcing, particularly as a way to give the customer a better selection of products — and more competitive pricing. "If you could do it all yourself, that would be great," NEC senior vice president Hank Josefczyk says. "But the increasing complexity of the industry and the products will continue to encourage partnerships."

VALERIE RICE

run up annual revenue of about $115 million. The 15-year-old company has only seen infringement notifications in the past year or so. "Your silhouette as a target goes up with size," observes senior vice president Martin Jurick.

However, there's a quick answer for those pinning ulterior motives on large companies' legal actions: "If you've worked long and hard to develop products, you have a right to protect them," states Wyse president White.

It's not cheap to do so, however. Which raises the issue of how much electronics companies should spend on protecting their intellectual property. Should patent departments be run as profit and loss centers? Few are, since it's so tough to assess a company's fiscal status with and without patent, copyright and trademark protection. However, several top corporate lawyers indicate their worth comes under scrutiny from management: "You can't avoid showing up as a cost," says AT&T's Keefauver, whose department includes 70 lawyers. □

The case of the walking brain

The electronics industry is an incestuous business. It is difficult to imagine it any other way. Where, for example, would the semiconductor industry be if a handful of employees hadn't left Fairchild Semiconductor Corp. to give birth to Advanced Micro Devices Inc., or Intel Corp.?

It is that entrepreneurial spirit — and mobility of talent — that has enabled the American electronics industry to flourish. But the process is not without its potential pitfalls. Trade secret theft by former employees is a concern at any high-tech company.

"Proprietary information is more dear than anything you have," says Gerard H. Langeler, president and COO at Mentor Graphics Corp., in Beaverton, Ore. Mentor has been on both sides of the trade secret fence, first as a start-up that spun off from Tektronix Inc., and then as a claimant in a case against former Mentor employees. In the first case, says Langeler, he and Thomas H. Bruggere, Mentor chairman and CEO, left Tek without a product in mind and with little reason to be accused of trade secret theft. But when the time came to determine Mentor's strategy, he and Bruggere thought carefully about whether or not Tek would have any reason to be upset with its two former employees.

Sending a warning

In the second case, Mentor sued four employees at EDA Systems Inc. They were able to settle out of court due to a noncompetition agreement one of the four had signed while at Mentor. According to Langeler, the suit was well worth the cost. In addition to settling that particular case, says Langeler, "you send a signal letting people know you won't let [trade secret theft] happen at your company."

Equally concerned are employees, who feel that they have a right to benefit from their own ingenuity. The Institute of Electrical and Electronic Engineers (IEEE) is endorsing legislation that would limit the rights a company has to its employees' inventions. "Most companies have very restrictive agreements that restrict innovation," says Stewart Bjornsson, chairman of the IEEE's Intellectual Property Committee. "Employee agreements have been used to squelch start-ups."

"Proprietary information is more dear than anything"
Mentor's Gerard Langeler

Trade secret litigation has hit something of a plateau since the early 1980s, when there was a significant rise in such activity, says Robert Alan Spanner, a partner with Beckford and Spanner, a law firm in Palo Alto, Calif. In 1983, for example, IBM sued Cybernex, a thin film media start-up founded by former IBM employees. In 1985, Apple Computer Inc. sued Steven Jobs for "secretly scheming" to misappropriate proprietary information about the company's next-generation computer. And, in the same year, Digital Equipment Corp. sued Emulex Corp., a Costa Mesa, Calif., maker of DEC-compatible storage technology for both trade secret theft and patent violations.

Most settled out of court

Things could heat up again, especially in highly competitive markets. "When competition is more intense, corporations are more nervous about losing trade secrets," says Steven J. Frank, an attorney with the high-technology group at Nutter, McClennen & Fish, in Boston. Indeed, some of the still-pending trade secret cases are in the hotly contested fields of software and artificial intelligence. Still in litigation, for example, are Computer Associates Inc.'s charges against two former employees for allegedly stealing trade secrets when they left for Duquesne Systems Inc. And Teknowledge Inc. has sued its former vice president for engineering, who subsequently founded Coherent Thought.

Most cases, though, are settled out of court. "Electronics is a very transient industry," says Rob Paglierani, intellectual property attorney at Prime Computer Inc. "The same thing could happen to us. Someone could come to work for Prime and we could find out they have taken something from their former employer. We don't want to get the reputation for coming out with all guns blazing," says Paglierani. "We may be the victim, too. We try to settle things amicably."

Still, says Paglierani, "there may come a time in the life of Prime, and in the life of every high-tech company, where we will have to sue because the information taken is vital to the company."

ANNE KNOWLES

IBM's PS/2 falters in the federal market

The biggest microcomputer market, the U.S. government, is not convinced PS/2 and OS/2 are the way of the future

BY JOHN M. DODGE

IBM is winning corporate customers with the seven-model PS/2 line, but the story in the less dynamic and more cost-conscious federal government market is dramatically different.

The Personal System/2 is primarily responsible for IBM's inability to hang onto a bigger piece of the single biggest microcomputer market. With PS/2s come an untested hardware architecture, peripherals that are incompatible with the existing PCs, relatively high prices and no solid alternative sources for the machines. Clearly, IBM will be challenged in winning over the Feds, especially the military.

To propel the PS/2 into standarddom, IBM is counting on widespread acceptance of OS/2, a powerful new operating system it is codeveloping with Microsoft Corp., of Redmond, Wash. Various releases of OS/2 will be shipped during the second half of this year, but it may be as many as two or three years before OS/2 takes off. Even without OS/2, IBM claims to have shipped 2 million PS/2s. From all indications, though, only a tiny fraction has been sold to federal customers.

As a microcomputer supplier, IBM was a distant No. 2 in the federal market last year. The General Services Administration (GSA) pegs IBM's share at 9.6% (just over 19,000 units) of the estimated 200,000 PCs purchased in the fiscal year ending Sept. 30. By comparison, the runaway leader, Zenith Data Systems, delivered 116,984 units for 59% of the 1987 market, GSA reports.

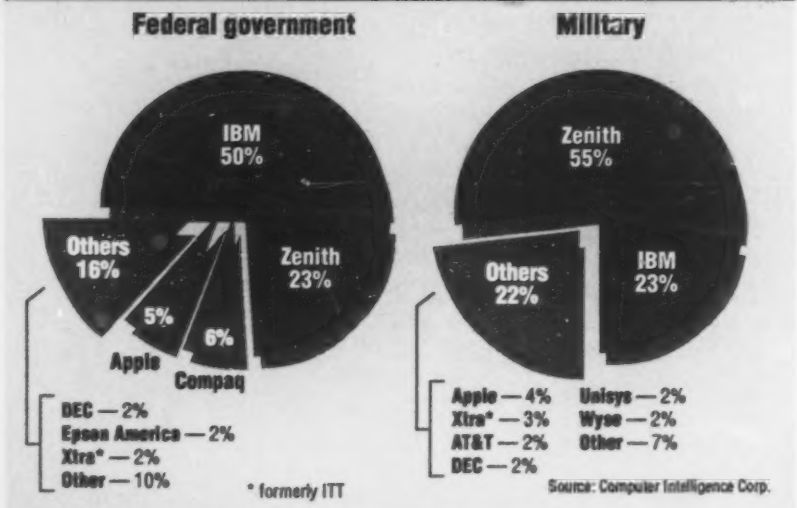
Maj. James McConeghy, small computer program officer for the U.S. Air Force, would dispute some of the GSA statistics. He estimates the military alone has 800,000 PCs. However, the Defense Logistics Agency, the source of the GSA's Department of Defense numbers, reported that the military owns 334,494 microcomputers. GSA survey manager Irene Bayol explains the accuracy of the survey report relies on responses from the various agencies, and as a result some machines might be omitted.

Sheer size alone — the government has 4 million employees — and IBM's huge government presence in mainframe computers and other data processing systems are two reasons why IBM's competitors are convinced the company will try to come roaring back with the PS/2. A recent GSA report says the number of microcomputers bought by the federal government in 1987 tripled over 1985 and that the agency's 1982 forecast — that the government would be using more than a million micros by the early 1990s — is on target. The report, which surveyed 77 agencies, says the government spent $694 million on microcomputers in 1987 and that the total installed base of 490,400 units is presently worth $1.78 billion.

Just the beginning

"It takes some time to build [demand] up. We are just beginning to see specifications for PS/2 functionality," according to Marvin Summers, manager of procurement contracts for IBM's National Federal Marketing division in Bethesda, Md. IBM claims that the advantages of the PS/2's Micro Channel architecture will become apparent when OS/2 takes off late this year. Consequently,

Installed base of PCs in government and military markets



IBM has half the PCs installed in the federal government, but only about a quarter of the military PC market

marketing pushes will emphasize the higher end of the product line, Models 50, 60, 80 and the new 70, rather than the Models 25 and 30 which cannot run the new operating system.

"IBM is very well thought of in the government, but I hear from customers that they are ignoring their installed base in their desire to establish a new expensive architecture. They cannot compete in the open architecture they established. I think they may be willing to walk away from some of the low margin business," posits a major competitor.

IBM won't publicly surrender the low-end business, but a company spokesman concedes that the more powerful and expensive Models 50 and 60 are selling best in the government. "As OS/2 software comes onto the marketplace, the PS/2 standard will come into its own . . . PCs are water under the bridge," says the spokesman.

That prediction is not shared by all. "We are not as sanguine about OS/2 as perhaps IBM is. The software is a lot more difficult to keep up with than the hardware. OS/2 has not done much in the [federal] government at all," says Roger Cooper, assistant deputy secretary of information systems at the Department of the Treasury, which according to the GSA is the biggest microcomputer user among civilian agencies.

PS/2 sites

The Internal Revenue Service, which is part of the Treasury, is one of the largest users of PS/2s, but according to Cooper, they were substituted to fill existing contracts for PC ATs which were all but pulled off the market to make way for PS/2s. In some cases, the PS/2s were priced below comparable ATs, Cooper adds. The prime contractor, Virginia-based systems integrator Sysorex, installed the systems in IRS Service Centers as data entry terminals.

Later this summer, the Treasury will award a $380 million microcomputer contract for 80386 and 80286 PCs, Apple Computer Inc. Macintoshes and local area networks, according to Cooper. IBM would not divulge whether it's bidding, but Cooper says he assumes IBM would not ignore such a lucrative contract.

Another comparatively large PS/2 site is the Department of Energy, where more than 500 machines are

in service, according to Philip Kief, DOE assistant press secretary. As with the Treasury, the machines were "technical upgrades" and are fulfilling a five-year, $30 million contract for 4,900 units, which IBM won in 1984 and which originally specified IBM PCs, Kief adds.

Other populations of PS/2s tend to be small. For example, the Department of Agriculture (USDA) is buying 15 Model 30s through a subcontractor for an Agricultural Stabilization and Conservation Service program, says Ray Suehr, leader of ASCS contracting services. The USDA presently buys 80286 and 80386 PCs through a $223 million contract with AT&T.

IBM won't reveal whether PS/2s have landed anything bigger than a GSA schedule, or contract, which generally range from $20 million to $30 million, according to Tom Buchsbaum, vice president of Zenith Federal Systems in Vienna, Va.

Military market

The military, which the GSA says accounts for 68% of all government-owned microcomputers, will be even a tougher market for IBM to crack. First, the military already favors Unix, a major competitor to OS/2. Second, whether the military likes OS/2 or not, it will be at least six months to a year before enough about it is known to get officials to buy into it. That's valuable time IBM loses to competitors. Third, the military is making one of the stronger bids in the government to standardize software and hardware and the PS/2s represent a departure from existing PCs.

Another problem is more basic — price and performance. PS/2s are more expensive than other microcomputers, although prices were recently cut and faster models (the Model 70-A21 at 25 MHz is an extremely fast 80386 PC) were added

IBM's federal future

IBM's share of the military microcomputer market will drop precipitously during the next year, predicts Computer Intelligence Corp.

The La Jolla, California-based market research firm conducted a telephone survey of 1,200 federal computer sites. In the overall federal market, IBM's microcomputer share will decline sharply, according to the CIC survey. IBM microcomputers represent 50% of the installed base, but during next year, 29% of the 600 sites with purchasing plans said they will buy Personal System/2s, says Tom Young, CIC PC analyst. Zenith Data Systems scored 35% of the mentions.

IBM can claim 23% of the military's microcomputers; Zenith, 55%. For military sites with purchasing plans for the next year, IBM was mentioned by 10% of the respondents; Zenith, by 68%.

The trend for IBM is much brighter in the corporate marketplace, CIC notes. Of the 8,000 sites surveyed also by telephone, IBM was responsible for 72% of the unit volume with 91% being PCs and 9%, PS/2s. Of the sites with buying plans, IBM garnered 76% of the mentions, showing strong support for PS/2s.

Certainly IBM would like to enjoy the same level of support in the federal government. But establishing the PS/2 as a hardware platform is a huge gamble, which has cost IBM a very strong position in the federal PC market. The challenge — significantly differentiating the PS/2 from the PC — apparently won't happen until OS/2 is proven and easy to understand in terms of applications. □

Tom Barrett

to the line. "I don't think [the PS/2] will do well until it competes from a price/performance standpoint. That's an absolute requirement," comments an Army program manager in charge of small computer acquisitions.

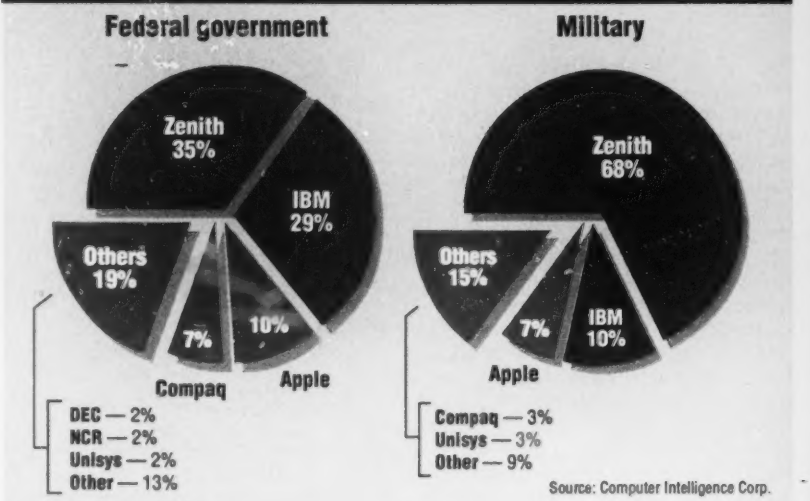
"There's nothing really pushing in the direction [of OS/2]. There's no lure for it. A lot of people [in the military] are keen on OS/2, but is there a functional requirement for it? It's too early to tell," says the Air Force's McConeghy, speaking from his office at Gunter Air Force Base in Montgomery, Ala.

Conversely, Unix is a proven multitasking operating system that is beginning to successfully address its major drawback, user unfriendliness. Unix already runs on the thousands of DOD minicomputers. The extent to which OS/2, which is not multitasking, is portable is an unknown, McConeghy points out. And the operating system's performance in conjunction with local area networks, an increasingly important consideration, is another OS/2 question mark, McConeghy adds.

"In a time of war, if the military has to withdraw from a foward to rear area, they want to be sure software that runs on one set of computers runs on all their computers," Zenith's Buchsbaum explains. This notion is known as "scalability" or "interoperatibility," which means, for example, that Unix applications that run on Digital Equipment Corp.'s minicomputers can be easily ported to microcomputers.

The PS/2 is not the first time IBM has launched a new hardware architecture without the required supporting software to make it a standard. When the original PC hit the ground, there was a paucity of software applications, although the DOS operating system was firmly in place. Whether history can repeat itself in the federal market, where the IBM PC was a smash hit, is questionable. □

Purchasing plans for PCs in government and military markets



Source: Computer Intelligence Corp.

Zenith PCs will be the most popular purchase with the federal government and the military next year

Zenith's crown jewel

The number of PCs that Zenith Data Systems has sold to the federal government is staggering.

The crown jewel in the profusion of highly profitable contracts Zenith has won is the Z-248 standard desktop contract to the Air Force. To date, Zenith has delivered 240,000 of the Z-248 80286-based PCs worth $715 million to the Air Force and the rest of the military which also buys from the contract, according to Maj. James McConeghy, USAF small computer program manager at Gunter Air Force Base in Montgomery, Ala.

"They have put forth an excellent technology and priced it very competitively. They priced the AT like an XT," McConeghy explains. The units range from $1,100 to $1,800, depending on storage and memory options.

In 1987 alone, Zenith sold PCs, related peripherals and software worth in excess of $500 million, says Tom Buchsbaum, vice president of Zenith Federal Systems in Vienna, Va. "We are quiet about it and we compete real hard," Buchsbaum says modestly about his company's success.

Zenith owns close to 60% of the federal micro market

The General Services Administration (GSA) reports that Zenith owned close to 60% of the federal market in 1987, supplying 117,000 of the 200,000 microcomputers the government bought. The Illinois-based company has also nailed down bids with the House of Representatives, the Internal Revenue Service and the U.S. Air Force for tens of thousands of laptop computers, and has an ongoing contract with the Navy and Air Force for 49,000 Tempest Z-150 and Z-200 PCs, 20,000 of which have been delivered.

The next mega-contract is what is known as Desktop III, which could call for as many as 200,000 to 300,000 desktop computers, says Buchsbaum. "I would not be surprised to see IBM competing for that." It's likely that Zenith and other experienced government contractors such as Compaq Computer Corp., Epson America Inc., NCR Corp., Unisys Corp., Wang Laboratories Inc. and Wyse Technology, will compete for it as well.

How long can 380MB drives keep spinning so fast?

The big drives may be in hot demand today, but manufacturers already need to watch tomorrow's needs — and keep an eye on what IBM, DEC and HP are up to

BY BRIAN DEAGON

The market for 380-megabyte hard disk drives, previously characterized as one of great stumbling and confusion, found its stride in 1988. Manufacturers and market analysts see it as a major growth industry for at least the next three years.

Signs of a robust market are evident. Almost every major disk drive supplier is shipping products, including Control Data Corp., Hewlett-Packard Co., Maxtor Corp., Micropolis Corp., MiniScribe Corp. and Priam Corp. Major system manufacturers routinely integrating the drives into their systems include AT&T, Apollo Computer Inc., Compaq Computer Corp., Sun Microsystems Inc. and Unisys Corp.

"It's an industry standard for us," says George Gardner, Apollo Computer product manager of personal computer workstations. Apollo has had engineering teams evaluate the drives intermittently for more than a year. Their most recent report was "very positive," says Gardner.

But for all the enthusiasm, it is a sector fraught with anxiety for the executives of those drive makers — and for management at the computer systems firms using the big drives. As demand ramps up, adequate sources of disk media and recording heads become crucial. And the influence of big users like Digital Equipment Corp. and large-scale rivals who also use 380MB drives, like HP, are issues that have industry executives on edge.

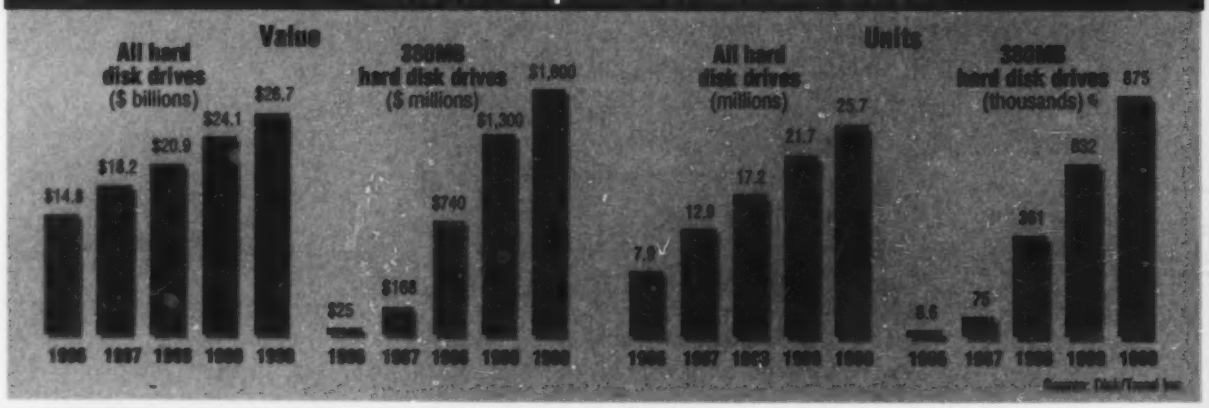
The development of 380MB drives was beset with problems early on. A critical shortage of recording heads and disks needed to build the drives forced layoffs and caused financial woes. Those problems have been resolved and disk drive vendors are rapidly expanding production capability to meet demand.

Worldwide shipments of 380MB drives increased to 75,000 units in 1987, compared with 8,600 in 1986. By 1990, shipments will increase to 875,000 annually, reports Disk/Trend Inc., a market research firm based in Mountain View, Calif. Sales of the drives will increase to $1.6 billion by 1990, up from $168 million in 1987 and $25 million in 1986. The robust forecast is related to the sustained growth of technical workstations, local-area networks, minicomputers and high-performance microcomputers that use the 80386 microprocessor.

"The name of the game for disk drive manufacturers now is to get designed into systems this year," says James Porter, Disk/Trend president. "Not getting in this year could mean not getting business later."

As would be expected, the early market leaders are the dominant players in the business. Maxtor claims to have at least five United States-based OEM customers, including Apollo. Micropolis also ships to Apollo, and to Compaq, Sun, Unisys and parts of AT&T. Maxtor introduced and shipped the first 380MB drive more than two years ago. It had

Worldwide shipments of hard disk drives



Sales of 380MB models are outstripping those of the hard disk drive market as a whole

pushed current technology to its limits in order to leave the competition behind, but since then about 14 disk drive vendors have jumped on the bandwagon.

One notable newcomer to the fray is Siemens Information Systems. It has the dubious distinction of being one of the first to break the 300MB barrier. However, at 310MB, the Siemens unit fell short of what the industry ultimately rallied behind.

Market solidarity

"The market has clearly solidified behind the 380MB approach," says Dennis Resnik, vice president of the Memory Products Division of Siemens Information Systems, Newbury Park, Calif. "Since we're late to market, our strategy is to emphasize performance," Resnik adds. The Siemens drive is enhanced to transfer data quicker than most other 380MB drives currently available.

Another relative newcomer is Toshiba America Inc., Irvine, Calif. "The 380 is what everyone was waiting for," agrees David Tovey, director for marketing for Toshiba's disk products division.

Taroon Kamdar, Maxtor director for marketing, says all major workstation vendors have or will soon announce 380MB-based high-end systems. "The power of 32-bit microprocessors is going to require high-performance disk drives and will propel demand," he notes.

The rapidity with which systems vendors have integrated the drives is primarily due to industry standards. Computer vendors have rallied around the 5.25-inch form factor and, more recently, the SCSI and ESDI interface which connects the drive to the computer system. The 380MB drive is also very similar in design to its 170MB predecessor.

James Stone, an analyst who follows the disk drive industry for Merrill Lynch Research & Economics in New York City, projects that three-fourths of all systems shipped with an 80386 microprocessor during the next year will include a 380MB disk drive as an option. The 380 costs about $500 more than the 170, but a user gets more than twice the memory capacity. The 170MB drive had a relatively short shelf life because most of its disk storage capacity was used up by the time software and other data-intensive requirements were loaded onto the system.

"The 380 is a good balance between system costs and storage needs," says Stone. The most successful disk drive companies grew 50% last year, will grow 40% this year and 30% a year thereafter, he adds. "That's extremely strong growth. Not too many technology areas are doing that."

The ease with which system engineers have been able to integrate the 380MB models into their systems caught the industry by suprise. As a result, drive makers are unable to meet a backlog of current orders. By the end of this year, the situation could change markedly, however.

Serious competition among disk drive vendors is expected by December, by which time the drive manufacturers are expected to be fully ramped up to meet most of the expected demand. For example, Micropolis should be building 35,000 drives per quarter this year, compared with 9,000 last January, says Dave Vellanti, director of storage research for International Data Corp. of Framingham, Mass., a market research company.

Three-fourths of all 386-based systems shipped in the next year will have 380MB drives as options

"Once customers see that orders can be met, some orders will evaporate. Supply will exceed demand and a lot of little companies could be hurt," projects Vellanti. "It's really a volume game and you've got to have some major customers in order to survive."

Key issues for drive makers in 1988 are in purchasing enough recording heads and disks. These products were previously in short supply, which caused several publicly held drive companies to rein in their quarterly projections. Adequate sourcing of these products could be critical to the 14 companies currently jockeying for market position.

A major supplier of thin-film recording heads, Read-Rite Corp., Milpitas, Calif., ran into serious difficulty last year. Because it reportedly ignored a key supplier that advised of certain changes to chemicals used to etch silicon in the development process, Read-Rite was unable to ship products. Read-Rite, now under new management, is returning to normal supply levels, and compared with a year ago, demand for its heads has more than doubled, up to 3 million.

Komag Inc. of Milpitas, Calif., a major supplier of thin-film disks used in the drives, expects to ship about 5 million disks this year, compared with less than 2 million last year. Most of the disks will be sold into the 380 market, says Hunt Payne, maketing vice president.

Three significant players

Three players could make a significant dent in the market, however. IBM, DEC and Hewlett-Packard have programs to build their own versions of the 380. However, DEC has yet to introduce any 380MB versions into its computer systems, and the word in the industry is that DEC is searching for 380 MB disk drives from outside sources. If so, it has the ability to absorb enough drives to potentially disrupt the activities of other systems vendors.

HP, which has received some disk drive orders from Prime Computer Inc. and AT&T, could challenge the industry in a different way. Aside from supplying its own internal needs for the big drives, HP is aggressively going after OEM deals. If successful, economies of scale in manufacturing could help it become a price/performance leader. The 380MB drive, when first introduced, cost about $3,000. Prices have since dropped to about $1,500 and are expected to soon drop further to $1,200 — especially now that buyers have begun planning for next-generation 760MB drives as well as for half-height 380s. □

Big systems integrators hit up their rivals for business

Systems integrators, like AT&T, IBM and other computer companies, are seeking potential customers in their peers

BY MARY JO FOLEY

To date, computer companies have been their own best customers for commercial systems integration (CSI). In other words, IBM has relied almost exclusively on its own systems-integration experts to design, automate, and link most of its in-house data-processing computer-integrated manufacturing, and other operation areas. AT&T, Computer Sciences Corp., Digital Equipment Corp. and the other top systems integrators have done the same.

But now that they have had a chance to hone their expertise, CSI vendors are ready to progress to designing, procuring, installing and maintaining systems for other firms, including other electronics and systems companies. If the CSI market is to grow from $1.5 billion in 1987, to $7.2 billion by 1992, as the Mountain View, Calif., market research firm Input predicts, these high-tech companies will need to be a big part of most CSI vendors' bread and butter.

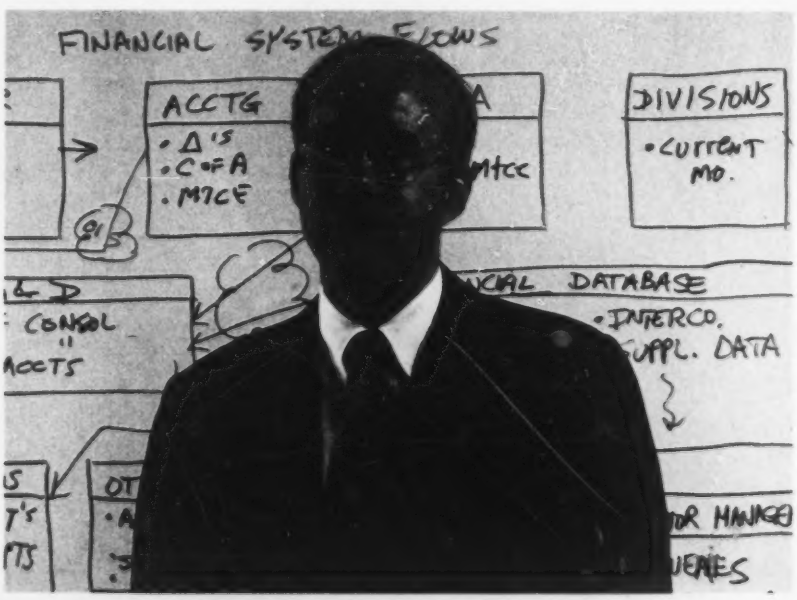
"Commercial users are finding they are over-hardwarized but under-computerized, just like the federal government," says Stephen McClellan, a securities vice president at Merrill, Lynch, Pierce, Fenner & Smith. "The biggest need is in the *Fortune* 1,000, and that's where the initial biggest demand will be."

Systems-integration vendors and customers in all industries are notoriously loathe to talk about their highly confidential integration projects. Nonetheless, word has gotten out about a few. For example, Computer Partners Inc., the Waltham, Mass., CSI subsidiary of Computer Sciences, is known to be enhancing and maintaining a complex circuit system for network systems planning for AT&T. Electronic Data Systems Corp., the celebrated systems-integration subsidiary of General Motors Corp., counts among its integration customers Korea's Lucky Goldstar Group.

IBM, for example, recently changed the name of its primary integration division from Federal Systems to Systems Integration in order to reflect the increasing importance of commercial sales to its overall integration business. According to Steve Carns, general manager of systems integration and professional services for IBM, last year Big Blue was part of 2,000 SI contracts, as either a prime- or subcontractor. Roughly 46% of the customers for IBM's SI services were among the top 50 of the *Fortune* 250, Carns says. In three-quarters of the bids it submitted for winning SI schemes, IBM bid non-IBM hardware alongside its own hardware, software and services, he adds. Carns predicts that the largest future SI contracts for IBM will be in the areas of health, telecommunications, computer-integrated manufacturing, in-house publishing and factory or office automation.

AT&T is another systems company gearing up to participate in CSI. In late March, the telecommunications giant formed a systems-integration division which will most likely focus on marketing the company's networking expertise.

Despite the name-brand recognition enjoyed by hardware vendors, professional service companies are as likely, if not more so, to win a sizable chunk of the CSI pie, industry watchers say. "No longer can a company



Suzanne Anderson

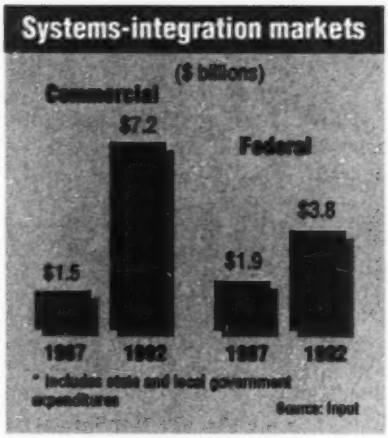
Contel's Kenneth Bottonari: "We felt EDS underperformed in terms of completeness and quality in the designated time frame"

be a service or a product company. Now one must be both," says Mel Bergstein, a partner in one such firm, Chicago-based Arthur Andersen & Company. "When clients want products, they call service companies first. The bottom line is you need to be a systems integrator."

Secret weapons

However, the extent to which CSI vendors will be able to capture the business of a substantial number of systems, software and service companies remains to be seen. In part, this uncertainty is due to the nature of the systems-integration business. Integration projects tend to be extremely complex. Many times, they are companies' "secret weapons," and as such, are key to their gaining and maintaining a competitive edge. Thus, a company which acts as another's systems integrator must be privy to a considerable amount of confidential technology and marketing data in order to do its job. In the case of computer and systems companies, the integrators with which they need to share this information are, or can be construed as being, their competitors.

In addition, as is true in the federal marketplace, CSI vendors often find themselves face to face with cost overruns, hard-to-meet deadlines, and other constraints. In government, customers routinely are expected to accommodate and absorb these setbacks; but in the commercial world, vendors pay for mistakes, both in dollars and negative future references.



Commercial systems integration business should grow twice as fast as the federal market

Electronics companies are no more likely to be immune from these drawbacks to systems integration than are banks, insurance companies or retail stores. Communications giant Contel Corp. is a case in point. By all outward appearances, Contel looked like a company ripe for systems integration. Two years ago, managers at the company's Atlanta corporate headquarters decided it needed a new billing information system. Contel put out a request for proposals and received bids from key systems companies, including Arthur Andersen, EDS, GTE Data Systems and IBM.

Contel opted to go with EDS, which began work on the project in September 1986. In December of the same year, Contel terminated the contract. "We felt EDS underperformed in terms of completeness and quality in the designated time frame," says Contel vice president for information management, Kenneth Bottonari. "The scope of the project was bigger than anyone originally understood." The project has gone into a reevaluation and replanning stage since. Currently, Contel is contemplating going the joint venture route to complete its billing system — an approach in which it engaged successfully on a similar financial and administrative reporting system in conjunction with Arthur Andersen, Bottonari says.

This isn't to imply that high-tech customers are impossible to please. The Montgomery-based Alabama Supercomputer Authority, for one, is more than satisfied with its CSI choice of Boeing Services Corp., according to director Ben Barnes.

The Authority, an advisory group charged with managing data systems for the state of Alabama's finance department, issued a request for proposals for a statewide supercomputer network in October 1986. In January 1987, the group unanimously decided to go with Boeing for the $39 million, five-and-a-half year contract.

"Even though they weren't the low-cost bidder of the six [which participated], they already had operated a supercomputer center in Seattle," explains Barnes. "They had a good overall understanding of supercomputers, and a high-quality staff." □

The golden rules of systems integration

William Hoover, chair and president of one of the most successful systems integrators — Computer Sciences Corp. of El Segundo, Calif. — offered an extended version of these remarks at a software and services management conference earlier this year.

What it takes to be a systems integrator:

• 1. Current and future integrators need to form strategic alliances to fill out their capabilities. No single company is likely to possess all of the resources and technology required to build the major information systems in the offing.

• 2. Not every company can be a prime contractor. This may be due to a company's own strategic direction, or because it simply lacks the management and technical structure to be a systems integrator.

• 3. To be a successful integrator, a company must have a culture that is oriented toward project management rather than toward professional services or a specific project. In order to build and maintain this cultural environment, you need:

a. Good project managers experienced in systems integration and a multidisciplined technical staff with proven expertise in hardware, communications, software, workstations and other relevant technologies.

b. Well enforced project management standards, methodologies and tools.

c. A structure for the evaluation of emerging technologies and existing products.

d. Solid support staff and functions, including experienced procurement staff; an established subcontractor management structure; material-management and project-accounting people; and a quality assurance team. □

European team effort breaks ground in software standards

Europe's $8 billion answer to Japan's Fifth-Generation Computer Project has yielded valuable new industrial- and office-automation standards

BY SIMON PARRY,

As the second phase of Esprit (European Programs of Research in Information Technology) gets ready to kick off, the European Commission, independent assessors and industry are studying hard the first four years of the programs.

And they mostly agree that Esprit 1 — the first phase of Europe's multinational, multibillion dollar answer to Japan's Fifth-Generation Computer Project — has largely been a success. Although the projects in the first phase have another year to run, the general prognosis is that Esprit 1 has challenged its three broad goals.

They were: to make the European information-technology (IT) industry more competitive; to engender cross-border collaboration within the community; and to develop internationally recognized standards.

The European Commission believes this success signals the revival of Europe's IT industry and hoists the warning flags to its U.S. and Japanese competitors. Five years ago, when the talking on Esprit started, Europe was in danger of being crushed. But now, the commission believes, the IT industry in Europe is healthy and has a significant and powerful role to play in the world's IT industry.

But while the commission's secretariat is understandably bullish about the success of Esprit 1, some independent assessors are more cautious. Paul Hare, an economist at Heriot-Watt University in Scotland, who is carrying out an independent assessment for the British government's Department of Trade and Industry, is one: "The great majority of responses I have had have been positive, but it's difficult to measure the concrete outcome of the projects. Collaboration is not very valuable unless products go on the market at the end of the day," he says.

Commercialization is indeed the predominant thrust of the soon-to-begin Esprit 2 phase.

Esprit's achievements come at a crucial time. Plans are well advanced for the single European market to be established in 1992. Europe will then become the world's third major homogeneous market. Market researcher Dataquest Inc. estimates that Europe's computer systems market was worth $35 billion in 1987, compared with $50 billion for the United States. By 1991, Europe will account for $50 billion and the United States, $65 billion.

Furthermore, if collaboration between European partners continues from the research laboratories out into the market, U.S. and Japanese competitors will face serious challenges. And with U.S. and Japanese computer firms adopting Esprit-developed standards, the Europeans could well have a large influence in North America and Japan.

Esprit 1 had a total budget of $3.88 billion (all figures calculated at an exchange rate of $1 = .54 pounds sterling) split 50-50 by the European commission and the participating companies. According to Esprit's annual report at the end of 1987, out of a total of 227 projects, 143 had produced results of "industrial significance," 27 had resulted in marketable products, 44 had products under development and 28 had contributed to an international standard. About 5% of the projects had been stopped or merged.

Results from Esprit, Phase 1

Out of 227 contracts for 204 separate projects...

... 143 produced results of "industrial significance."

Examples: Project 554, "Spectra," aimed at developing a submicron CMOS semiconductor process;

Project 820, Italian/French/German consortium producing an intelligent knowledge-based system for process control.

... 27 resulted in marketable products.

Example: Project 1085, the supercomputer built from arrays of Transputer processors, which is now being marketed by Thorn-EMI under the name "Parsys."

... 44 had products under development.

Example: Project 532, a software package for real-time generation and display of two and a half dimensional sketches for moving scenes.

... some contributed to an international standard.

Example: Project 8613, Office Document Architecture, which has been accepted by the International Standards Institute.

Source: European Commission

Useful spin-off

There have been some solid examples of useful spin-off from Esprit. A senior Esprit official who declined identification says a "key intention" has been to develop software standards. This would act as a supporting movement for the onset of the single European market; everybody would know how to build computers that could be sold throughout the community.

The Communications Network for Manufactur-

ing Applications (CNMA) is a good example; it is already starting to change the way in which European factories run. CNMA is Europe's contribution to Manufacturing Automation Protocol (MAP), the factory communications standard developed by General Motors Corp., but it is more wide ranging. The project was led by British Aerospace Plc and involves a consortium of 13 users, vendors and systems organizations from four countries including Germany's BMW AG, France's Peugeot Groupe SA and Italy's Alitalia Plc.

Work started in 1986, and last year the consortium was able to demonstrate the interworking of robots and other production equipment from a number of manufacturers. Now there is a fully installed and working production line in BMW's car plant in Rogensburg, West Germany. The automatic line helps build BMW's top-of-the-line 3 and 5 series models.

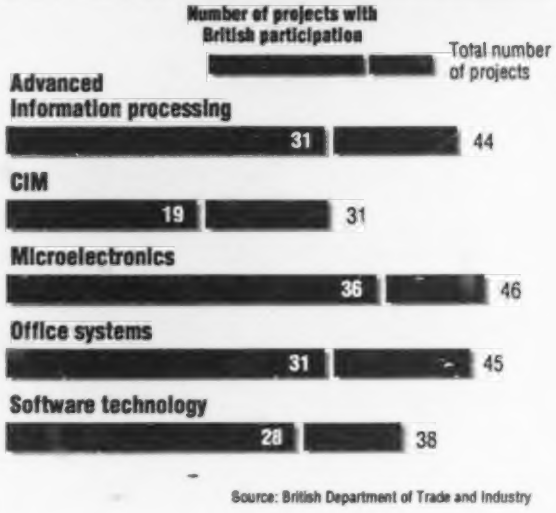
This was the world's first factory implementation of the Manufacturing Message Service, a major element of MAP version 3.0.

A second CNMA production line is being established at a British Aerospace plant to build wings for the Airbus passenger jet. Later this year Alitalia will also install a CNMA production line which will be linked to the British Aerospace line via a wide area network.

Similarly, the Office Document Architecture (ODA) is a formatting standard whereby files can be passed from one desktop computer to another. The main participants in this project are computer makers Ing. C. Olivetti and Co., Siemens AG, Groupe Bull and ICL.

The ODA was accepted last year by the International Standards Institute, of which IBM is a member. Siemens is leading a second project to extend the architecture to text, image and voice documents. "Clearly," says the Esprit official, "this program is just not about manufacturing products. We needed to produce the technology which could then be pulled through to products."

Britain is one of Esprit's strongest players



Source: British Department of Trade and Industry

As an example, he cites Project 1085, which involved successful assembly of a supercomputer from arrays of Inmos Plc Transputer processors with a performance comparable to that of a Cray supercomputer, but at a fraction of the cost. The supercomputers, called Parsys machines, will be sold by the British firm Thorn-EMI and by French firm Telmat.

But now Esprit executives have their time well filled with setting up the second phase. Esprit 2 has a slightly larger budget of $4.14 billion; the commission has received over 700 proposals.

U.S. and Japanese firms have been able to participate in Esprit

The proposals will be sorted until the commission has given its approval to about 150 projects. The commission is rushing through the work so that research contracts can be awarded during the summer.

The Esprit mandarin hopes that an increased budget would attract "more important projects" which would be allowed increased individual budgets up to $37 million. "It came out quite clearly in our first interim review," he says, "that we had to have deeper research and bigger projects."

U.S. participation

Interestingly, U.S. and Japanese firms have been able to participate in Esprit projects. Indeed, the commission has not shied from using scare talk of U.S. and Japanese threats to bludgeon both governments and companies into investing in the program, but yet has not excluded non-Europeans from having a useful input. This U.S. involvement has not been without its humorous side: there was an early glitch in a CIM project, in which it apparently had not occurred to management at Digital Equipment Corp.'s Clonmel, Ireland, plant that its Italian collaborators would not speak English.

Some U.S. participants believe they have a critical role to play in making Esprit work. "In the case of Esprit, if it has been to the benefit of the European community to bring in U.S. companies, it's done," says Wilfred J. Corrigan, chairman of ASIC chip maker LSI Logic Corp. Corrigan and others are less open when non-U.S. participation in pro-U.S. electronics industry projects like Sematech are discussed.

Economist and Esprit-watcher Paul Hare wants Esprit 2 to concentrate on commercial exploitation of technologies, in line, he said, with the framework for the phase set out by the commission. "I would want Esprit 2 to be the magnet that pulls the good products out," he explains.

Hare also believes there will be a marked difference in the size of companies that participate in Esprit projects. Small companies had been particularly successful in Esprit 1 and deserve a lot of the credit for commercial exploitation.

"Two-thirds of the Esprit 1 projects involved small companies and they would have been unable to participate without clear products in mind. They could not afford the resources otherwise," he says. However, the commission has a declared goal of bigger projects for Esprit 2, which would tend to preclude small company involvement. □

CD-ROMs: Prices fall and shipments begin to spin

More applications and even lower price tags are needed, but manufacturers and customers are finally interested

BY BRIAN DEAGON

A few months ago, a Hewlett-Packard Co. spokesman announced to a group of customers that the 65 manuals needed to support its minicomputer would soon be available on one 4.7-inch CD-ROM. The crowd of users interrupted the speaker with applause. Some even stood and hollered encouragement.

"Our customers went wild," says Doug Chapin, HP product marketing manager in Mountain View, Calif. "It's been a major challenge for them to access documents needed to support our HP3000 minicomputer."

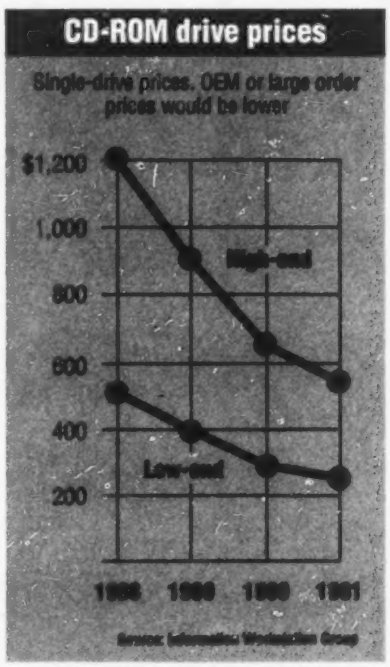
The technology is worth whooping about. Few peripheral computer products introduced during the past five years have offered so much for so little. One small shiny compact disc, read-only memory stores more than 600 megabytes of data, equal to 1,500 floppy diskettes, 250,000 pages of text or a stack of documents 25 feet high. It can also hold 5,000 images or 16 hours of sound. The discs are rugged, easily transportable and unharmed by normal temperature fluctuations or magnetic fields.

Lately, the hoopla surrounding CD-ROM is coming from potential users and not from the manufacturers themselves. The promoters of CD-ROM technology are breathing sighs of relief. They were charged with being overly infatuated with the technology and less concerned about developing useful applications. As a result, millions of dollars were wasted promoting CD-ROM to an uninformed end-user community. CD-ROM stumbled through its first two years of marketing.

"The technology was more hype than hope," says Robert Katzive, vice president of Disk/Trend Inc., a Mountain View, Calif., research and consulting organization. "The real problem was that CD-ROM was a publishing medium and the publishers didn't have their wares in the market."

But that is changing. CD-ROM has the potential to radically change the way information is cataloged and delivered, in the same manner that its audio disc cousin changed the record industry. Since the genesis of CD-ROM in the early 1980s by N.V. Philips of the Netherlands and Sony Corp. of Japan, businesses have sprung up in support. About 15 manufacturers now sell the drives, at least 30 companies prepare data to put on discs, and more than 40 software houses write for CD-ROM applications.

According to a report by Freeman Associates Inc., a market research firm based in Santa Barbara, Calif., the value of CD-ROM shipments will rise to about $143 million in 1991, from about $69 million this year.



Stamp of approval

Several influential computer companies are poised to capitalize on CD-ROM. Developers of CD-ROM technology include Hitachi America Inc., Laser Magnetic Storage Inc., of Colorado Springs, Philips, Sony and 3M Co. Aggressive promoters and suppliers also include Amdek Corp., Apple Computer Inc., Digital Equipment Corp., Lotus Development Corp., Microsoft Corp. and Wang Laboratories Inc. The notable holdout is IBM, which has expressed considerable interest in optical technology. IBM showed a CD-ROM prototype, albeit someone else's drive, at a technical trade show in April. It sells a write-once, read many times (WORM) drive through regular channels, notes Dave Liddell, IBM manager for marketing programs for image applications development.

"The advantages to CD-ROM are so unique and valuable that it's inevitable this technology will be used broadly," insists Carl Stork, Microsoft director of CD-ROM marketing.

The industry's hope for a new beginning rests largely on the acceptance of mainstream business, which is starting to happen. For example, HP developed a parts catalog for Ford Motor Co. Lotus compiles a weekly financial database on discs. And London-based British Airways is testing a CD-ROM application that contains the entire parts catalog of a Boeing 757, about 12,000 pages of text and 6,000 full page drawings, onto one disc.

"That's 140 pounds of raw paper delivered on one disc," notes Chris Bowman, director for marketing and sales at KnowledgeSet Corp., a devel-

oper of CD-ROM softw[illegible]ased in Monterey, Calif. Customer interest has "increased enormously" during the past six months, says Bowman. Most customers are still developing prototypes because the cost of full-blown production is still too high for many, Bowman notes.

Another company evaluating CD-ROM is International Property Control Systems, a Phoenix, Arizona-based value-added reseller (VAR) of IBM systems. The company, which includes a chain of 450 restaurants and hotels among its customers, has put 33 floppy diskettes, 8 hours of recorded tape and 10 binders of data onto one CD-ROM disc. It will be used as an interactive training device.

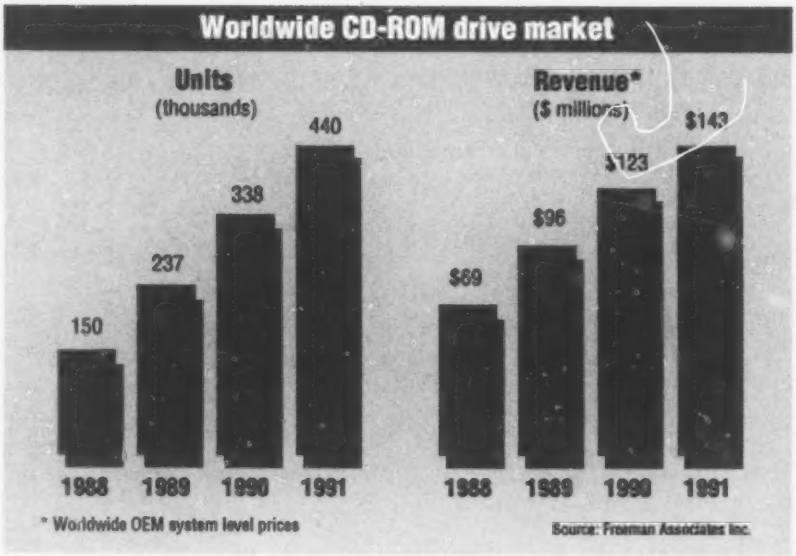
"I'm thrilled with the technology. The capabilities are phenomenal," agrees Carolyn Keith, IPCS training development manager. But a current roadblock is that the drives are "awfully expensive," she adds. It is a comment frequently echoed.

Market obstacles

Obstacles to the large-scale acceptance of CD-ROM are the high cost of entering the market and the dearth of CD-ROM applications. These barriers are slowly being chipped away through the efforts of the High Sierra Group, a consortium of industry players who agreed on how data would be placed onto the discs, in a manner that would be consistent from one drive to the next. Microsoft also developed a software operating system that allows an entire CD-ROM disc to be read as though it were one massive floppy or hard disk drive running under MS/DOS.

Meridian Data Inc., Capitola, Calif., chipped in by developing software that reduces the time and cost of designing and mastering a CD-ROM disc for mass distribution. It typically costs about $4,000 to make one master, but several masters are usually needed to get the bugs out of one application, easily driving costs above $20,000. Once mastered, duplicate discs can be made for about $4 each.

"CD-ROM has been overhyped but it's also on a steady growth path. It's beginning to catch up to the hype," says John Gale, president of Information Workstation Group, Alexandria, Va., a consulting and market research group for optical technologies. "All the basic standards are now in place."



The result of this activity is that software developers have an easier time creating CD-ROM disc applications, while original equipment manufacturers, system integrators and VARs have an easier time implementing the technology. Currently, not enough application discs — sometimes called titles — are available to generate large-scale demand for the drives. Industry watchers agree that upward of 1,000 mastered discs with broad consumer appeal are needed. More than 2,000 master audio discs were available before consumers invested in CD audio players in a big way, notes Scott McReady, an analyst with CAP International, a market research organization in Marshfield, Mass.

Meridian Data developed software that reduces the time and cost of designing a CD-ROM disc

Somewhere between 100 and 200 general titles currently exist, aimed primarily at legal, medical, financial, library and scientific markets. CD-ROM discs are frequently used as directories, catalogs and parts lists. Many more discs are developed for internal applications for a company. In total, about 700 CD-ROM disc titles have been mastered.

"There are not enough CD-ROM titles to support a rapid growth," says McReady. "We've still 18 to 24 months to go before enough published titles are available for the market to take off," he estimates.

Nonetheless, market interest continues to grow. At the third CD-ROM international conference sponsored by Microsoft in March, about 2,000 people attended, compared with 1,300 a year ago. Apple used the show to introduce its first CD-ROM product for the Macintosh and Apple II computers, priced at $1,199. Nine additional companies announced they would support the Apple drive with various products.

Microsoft has published three titles aimed squarely at the consumer market. And perhaps as a precursor of things to come, McGraw-Hill Book Co. has published a paperback described as a comprehensive primer for the next wave of CD-ROM technology. New versions of CD-ROM will have multimedia capabilities, combining audio, digital, still graphics, sound and moving pictures. The book was authored by technical staffers at Philips.

"There is nothing to drive this industry to dizzying highs overnight," notes Disk/Trend's Katzive. "But those companies that hang on now and pay their dues will be repaid downstream." □

Can analog design software revitalize communications?

Yes, by providing product differentiation. But that doesn't make life any easier for U.S. equipment makers

For the past four quarters, growth in the Federal Reserve Board's index of industrial production of communication equipment has slowed down to a crawl. But this should not be discouraging, reminds Cahners' senior economist Elizabeth Baatz, because the FRB index consists mostly of military communications equipment. This segment has gone on a diet with the freeze of new defense programs, and is unlikely to get refired.

The commercial components of the index may be doing a little better. AT&T's revenue increased by 3% in the first half of 1988, but most of this growth is coming from services such as long distance, rather than from sales of equipment. Northern Telecom Inc. did a little better at 5%. Only half of its production, however, is in the United States, and thus counted in the FRB index. The other half is in Canada, Northern Telecom's home base. And, increasingly, the company is contracting for subassemblies made in Korea by Daewoo.

What could bring growth back to the U.S. communication equipment manufacturers is the increasing availability of productivity-enhancing software tools for analog IC design. Analog and mixed-signal (analog plus digital) ICs are at the heart of every new piece of communications equipment, from PC-grade modems to PBXs to the telephone utilities' central office equipment. But, even though SPICE (simulation program with IC emphasis), the classical computer program used to model the behavior of analog chips, is one of the oldest CAD programs, designers of analog ICs lack the range of low-cost software tools available to their digital colleagues.

Analog Devices Inc., the leading manufacturer of analog chips, is now investing "significantly" in both homegrown and commercial tools, says chairman and president Ray Stata. At the same time, the company's five-year plan calls for "dedicating increasing resources to address the communications markets, especially at the high end of the modem business," he adds. Rockwell International Corp., which dominates the market for modem chips, uses its own software for complex designs on Digital Equipment Corp. VAX computers and commercial software to enter the design parameters on PCs.

Martin Walker, vice president of software vendor Analog Design Tools Inc., admits that the analog gurus who design ADI's chips prefer to build their own tools. But he believes that, by involving designers who have not developed their own analog design software, mixed-signal chips will increase the demand for commercial tools made by companies such as his. Examples are logic designers who must craft the analog portion of their chips, and test engineers who must interface the new chips with their testers.

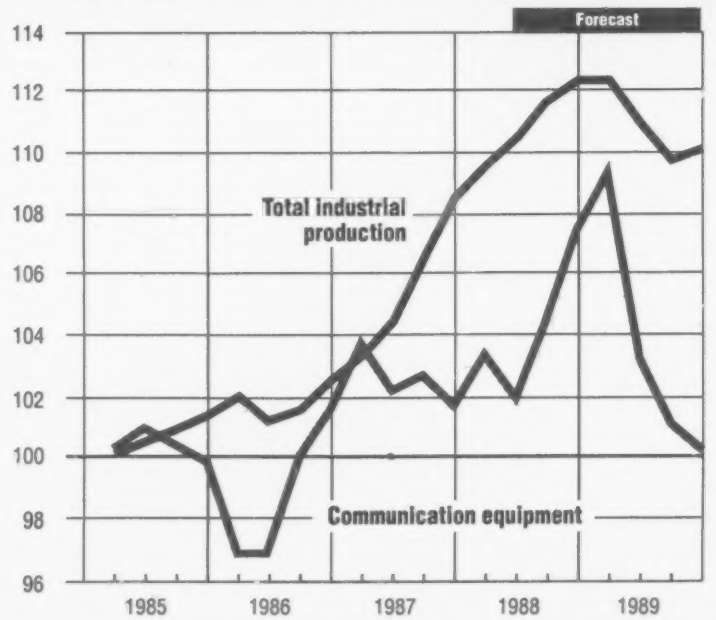
As the name of the company implies, the strength of LSI Logic Corp.'s engineers is in digital design. Yet, like ADI, this leading maker of ASICs is also developing its own software to design its future generation of mixed-signal ASICs. The reason, says marketing vice president Robert N. Blair, is that the design software must be tightly coupled with LSI Logic's design environment. "This is far more critical with analog than with digital circuits," he explains.

Where both Blair and Walker agree is in the promise of mixed-signal chips for equipment manufacturers. "Product design starts with the IC," says Blair. "The name of the game is differentiation in cost, features and/or size." While mixed-signal chips shrink product cost and size, he adds, "analog gives you differentiation." Walker, however, comments wryly that NEC Corp., a leading Japanese manufacturer of communications equipment, already uses his company's tools to design differentiated products.

ALBERTO SOCOLOVSKY

Communication equipment production index

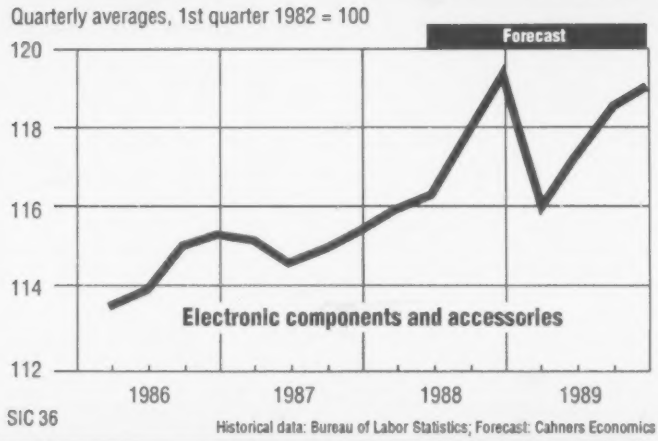
Quarterly averages, 1st quarter 1985 = 100, seasonally adjusted



SIC 366

Historical data: Federal Reserve Board; Forecast: Cahners Economics

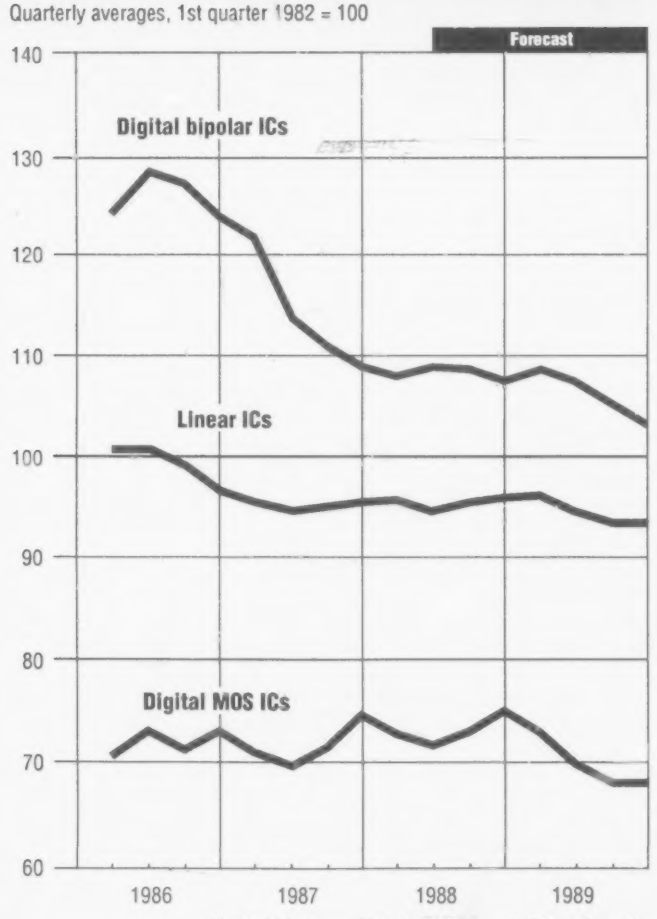
Producer price index — Electronic components



SIC 36

Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Active components



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

IC prices will rise slowly through early 1989

After three years of annual price declines, linear IC prices rose 0.3% in the first quarter of 1988 from a year ago. Prices are expected to continue rising through the first quarter of 1989, but this rise will be very slow. All told, the linear IC price increase will be only 0.3% in 1988, followed by a 1.2% decline in 1989.

Digital MOS ICs, which haven't seen a price increase in the past three years, are also seeing higher prices. In the first quarter, prices showed a 2.8% inflationary gain, compared with a year ago. These prices appear headed for similar increases in the next few months. By the end of 1988, annual producer prices for digital MOS are expected to rise 2.3%. But this increase will be short lived, as another 4.4% price decline is likely in 1989.

Digital bipolar ICs continued to show a severe deflationary trend. The producer price index stood at 108.4 in the first quarter of 1988, which is 11% below the price index of a year earlier. In 1988, price levels are expected to remain relatively stable. Because of higher prices in the first quarter of 1987, bipolar IC producer prices will register about a 4.8% price decline in 1988.

Understanding producer prices

What does all this producer price data mean? First, remember that producer price indexes from the U.S. Labor Department simply measure average changes in prices received by domestic producers. They are obtained by confidential surveys of a sample of the industry. Also, they are designed to measure changes only in domestic output, so imports are not covered.

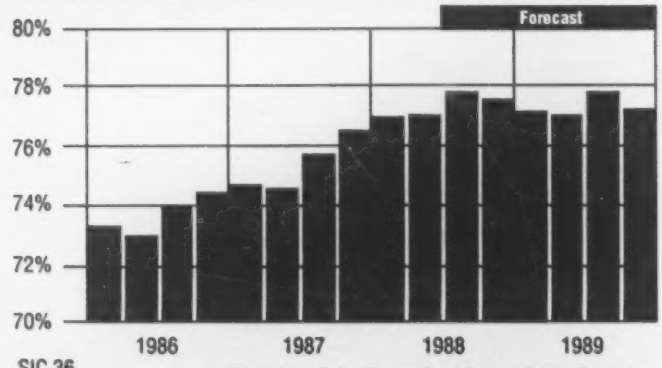
Producer prices are expressed as index values in order to disguise the actual dollar value of a price. In this way, the Labor Department does not reveal any specific company price data and insures confidentiality. The best way to look at any price index is to calculate the annual percentage change in the index. This gives some relative measure of an inflation rate for a product.

If the percentage change in a price index is rising quickly, then we have some idea of the inflationary prospects for a particular product's price. In the case of electronic components, despite the DRAM price panic, most other component product prices are rising only slowly, which bodes well for electronic industry product prices holding steady as well.

ELIZABETH BAATZ

Plant utilization — Electrical machinery

Average percentage of capacity utilized per quarter, seasonally adjusted

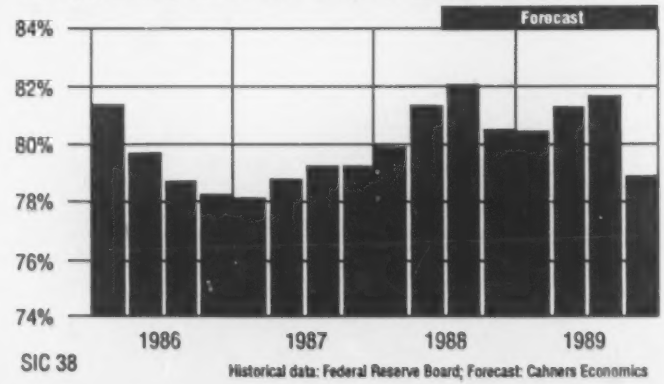


SIC 36

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Instruments

Average percentage of capacity utilized per quarter, seasonally adjusted

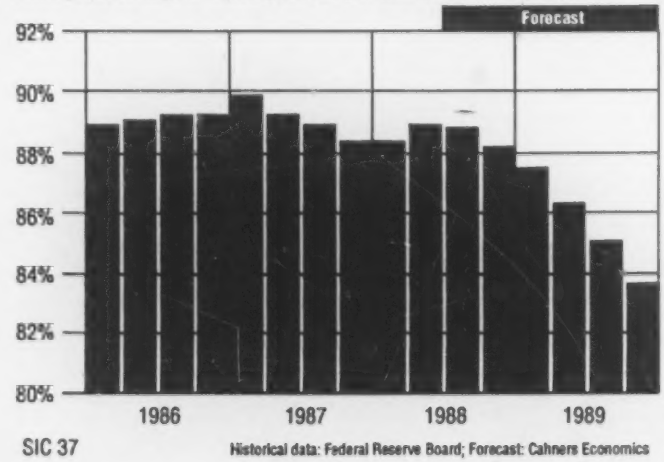


SIC 38

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Aerospace

Average percentage of capacity utilized per quarter, seasonally adjusted



SIC 37

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Capacity utilization rates are still on the rise

Operating rates in the manufacturing sector averaged 83.1% in May, marking the third straight month of increases. Manufacturing capacity utilization has been above its 1984 peak value of 81.3% since October of last year and more increases are expected.

Tight capacity constraints are squeezing output in several of the process industries, particularly in the materials sector. Utilization rates for paper are at 100%; aluminum hovers at 97%; chemicals and raw steel are at around 90%, and the energy materials sector utilizes about 85% of capacity.

The durable goods sector has a little more breathing room. At an operating rate of 81.6% in May, durable goods utilization continued to climb from its most recent low of 75.1%, back in June 1986.

Overall, electronics is in good shape

Constrained capacity is not a factor choking off the expansion in the electronics and electrical machinery industry. True, the operating rate for this industry is about 5.6 points above its most recent low of 72%, but it is safely below the 82.3% mark hit back in 1984. Our forecasts keep the rate below 78% throughout next year.

Plant capacity utilization rates for electronic manufacturers, based on *Electronics Purchasing* magazine's monthly survey, indicate the electronics portion is operating under tighter capacity conditions than average. The utilization rate climbed to 84% in June, tying its old record of four years ago. That is the highest rate the survey has ever recorded since its beginning in 1983.

The story for the instruments industry is much the same as the electrical machinery industry. The May utilization rate of 80.3% is 2.6 points over the last cyclical low, but not yet close to the 85.7% peak of four years ago. The industry will have enough capacity to allow for continued production growth through next year without operating rates rising above the 82% mark.

Capacity utilization rates for the aerospace and miscellaneous transportation industry are relatively high, but on a slow descent. From a peak of 90% in March 1987, the operating rate subsided to 86.3% in May of this year. With real defense dollars shrinking, operating rates in the aerospace industry will continue to recede along with the cutback in production. Even so, utilization rates will tease the 83% mark by the end of 1989. That is well above the industry's 21-year average of 77.7%.

ELIZABETH BAATZ

Computers, office machinery rebound

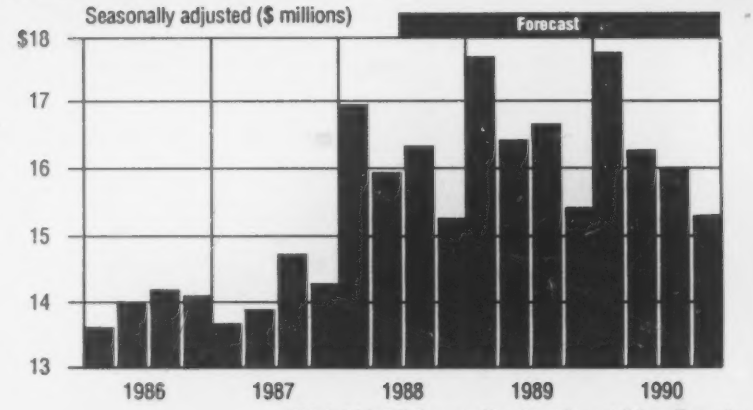
April new orders and shipments for computers and office machinery cooled from the fast pace of the first three months of this year. New orders dropped about 0.5% from March to April, while shipments sunk 8.8% over the month. Recall though, that the heated first quarter activity was a rebound from the sharp, but short curtailment after the stock market crash. So, these one-month setbacks are most likely not precursors to a downward trend at this point.

The $5.3 billion in new orders was still 8% above the same month last year and shipments of $5.19 billion stood 11% greater than last April. The inventory-to-shipments ratio did shoot up to 1.95 in April, up from 1.78 in March because of the tapering off in shipments; but, historically, the I/S ratio for this industry has been in the 2.0 to 3.0 range, so the latest figure is still below the critical mark.

Figures confirm that businesses continue to pour dollars into new computer equipment. Purchases of information processing and related equipment totaled $159.67 billion in the first quarter of this year at an annualized rate (constant 1982 dollars, seasonally adjusted). Of that, almost two-thirds went for computers and office machinery.

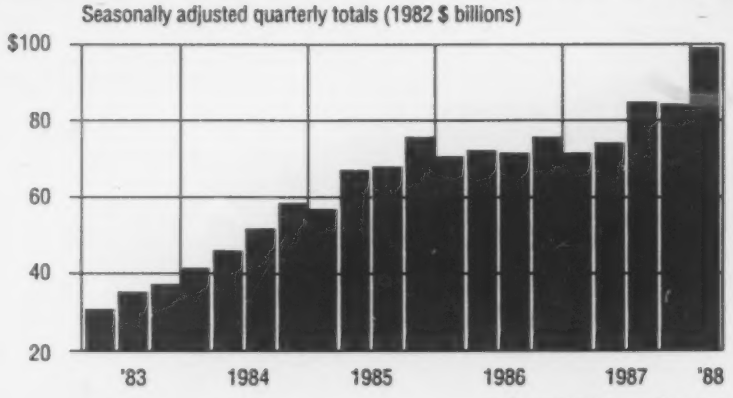
More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158. Phone: (617) 964-3030.

Computers and office machinery — Shipments



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Private purchases of computers and office equipment



Source: U.S. Commerce Department

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, April)	308.6	304.9	+1.21%	284.5	+8.47%	322.5	+4.50%
Shipments (SA, $ millions, April)	$5,191	$5,695	-8.85%	$4,663	+11.32%	$5,479	+5.55%
New orders (SA, $ millions, April)	$5,309	$5,340	-0.58%	$4,913	+8.06%	$5,806	+9.37%
Unfilled orders (SA, $ millions, April)	$18,658	$18,540	+0.64%	$19,013	-1.87%	$20,200	+8.26%
Inventory-to-shipment ratio (SA, April)	1.95	1.78	—	2.06	—	1.97	—
All employees (thousands, April)	503.9	502.1	+0.36%	478.5	+5.31%	489	-2.92%
Production workers (thousands, April)	168.4	168.5	-0.06%	158.5	+6.25%	155.0	-7.97%
Exports ($ millions, March)	$2,175	$1,733	+25.5%	$1,685	+29.07%	$1,835	-15.64%
Imports ($ millions, March)	$2,051	$1,849	+10.91%	$1,557	+31.72%	$1,800	-12.27%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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ectronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE SEPTEMBER 1, 1988

POWER OF ATTORNEY

How Intel holds on to its technology assets PAGE 30

Beating the high cost of test PAGE 112

Sensors star in car wars PAGE 102

Thomas Dunlap
Intel's executive vice president and general counsel

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 17 SEPTEMBER 1, 1988

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30 Power of attorney: How Intel defends its technology rights

In this, the second section in a three-part series on intellectual property protection, ELECTRONIC BUSINESS outlines the hard-line strategies adopted by Intel Corp. and Digital Equipment Corp., and examines the impact of those strategies on customers and competitors. It also looks at how Japan's electronics executives, far from worrying about being sued for infringements by U.S. companies, are themselves on the offensive in defending their technology rights.

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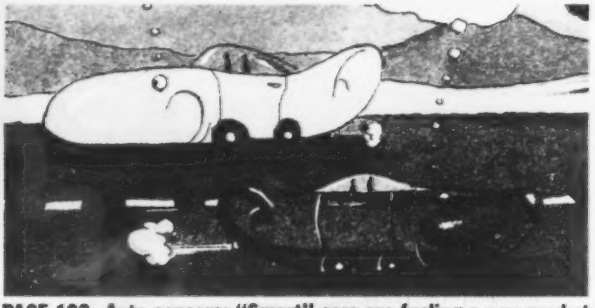

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Don't tread on them

To more than a few executives in this business, Intel is becoming the company they love to hate. The haters feel that way because they happen to be targeted by the chip giant as it fights to keep what it holds dearest: its intellectual property.

Electronics companies spend more than many to foster technology, and the last thing they want is to see it ripped off. That's why patents, copyrights and trademarks have become more important than ever, and why, in the last year or so, acrimonious legal battles for custody of a particular invention or process have raged, at immense cost to all involved. Just look at some of the big lawsuits now running: Apple versus Hewlett-Packard; Intel versus NEC. So we decided to take a serious look at the extent of the problem and at the way some of the big guys handle it.

Intel handles it with an aggressive "don't tread on me" attitude, as associate editor Valerie Rice ably explains in her cover story. The same goes for DEC, whose feisty stance has put several smaller companies off their strategic stride.

Are DEC and Intel only doing what's right to protect what's theirs? Or are they using bullying legal tactics that do the industry at large little good? And is a month or two spent preparing for courtroom battles really a productive way to spend your marketing vice president's time? Read on — and don't miss the 12-point guide to intellectual-property protection in our next issue.

Associate editor Valerie Rice

This week's special is . . .

Their promoters would hate to hear us call them gadgetry, but what else do you call the little electronic gizmos that you may soon see on supermarket shelves? Our story on the emergence of digital shelf labels, which update this week's price of your favorite breakfast cereal by remote, caters to a very human fascination with gadgets — and points to potentially huge buys of low-cost LCDs and microprocessors. Spare a thought, though, for all the bored 5-year-olds soon to be deprived of the joy of sliding the plastic labels every which way.

JOHN KERR

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BPA ABP

Education and liberty

I just finished reading Frank Burge's "My View" titled, "Education: The safeguard of liberty" in your July 1 issue and I was horrified [by the story of a worker who couldn't communicate well enough to do her job].

My greatest concerns are the drug probem and the basic educational system of the U.S. I believe that the educational system can help attack the drug problem, so it is very important.

Young people come out of the educational system (through high school) with a very poor general education. It is hard to compete in the world markets with the Japanese when you don't know what Japan is or even where it is.

It doesn't matter whom we blame, but I agree that action is required. By the way, I blame the parents who don't care enough about their own children's education. The same school systems that are turning out functional illiterates also turn out extremely well educated Chinese, Vietnamese and Cuban children. The difference is that the parents have respect for education. In fact, the parents have a passion for education.

Amaury Piedra
President and Chief Executive Officer
Seattle Silicon Corp.
Bellevue, Wash.

CAE wins with licensing

Your CAE software article in the June 1 issue was a good summary of why software and hardware are still bundled together in the CAE business. But I think that the sidebar doesn't do justice to network licensing. Someone probably dismissed the first Intel Corp. microprocessor, the 4004, as "just a collection of transistors." I think that you may be doing the same thing by calling network license software just "creative software pricing 101."

Valid Logic Systems Inc.'s access product follows on the heels of Apollo Computer Inc.'s Network License Server and Digital Equipment Corp.'s License Management Facility. In a recent study of network licensing, we identified more than 20 other vendors who will offer "floating" software as an alternative to CPU-locked software before yearend. Network licensing will be a major factor in deciding who wins and loses in the battle for the corporate purse. It allows companies to license software in a flexible way that better matches their needs. Firms can at last share infrequently used, expensive software across an unprecedented number of users.

Network licensing will increase CAE penetration. Improved design quality and manufacturing productivity are the likely results. Network licensing may lead to creative pricing and interesting negotiations. But the real winners will be the CAE vendors and their customers who use network licensing of software as a strategic technology.

James H. Geisman
President
Marketshare Inc.
Wayland, Mass.

Corrections

In the May 1 issue of ELECTRONIC BUSINESS, we misidentified the appropriate contact at the Hong Kong Government Industrial Promotion Office. Donald M. Fletcher is now the principal consultant at the group's San Francisco office.

We inadvertently left Weiss, Peck & Greer off our May 15 listing of top venture capital companies. Robert J. Loarie is the contact at the Palo Alto, Calif., firm that has nearly $170 million in venture capital funds. Also omitted was The Vista Group, a New Canaan, Conn., firm with $203 million in capital. Gerald B. Bay is the contact.

In our June 1 ranking of the most profitable companies, we neglected to include Network Systems Corp. From 1982 to 1987, Network Systems posted an average 33.5% growth per year. The Minneapolis-based firm makes and sells datacommunications systems that interconnect computers from most major manufacturers.

And, due to an error in filmmaking, the chart accompanying our August 1 story on Hewlett-Packard was unintelligible. The chart is reproduced correctly on this page.

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers. If not written on organizational letterhead, all letters must include a telephone number. ELECTRONIC BUSINESS reserves the right to edit letters.
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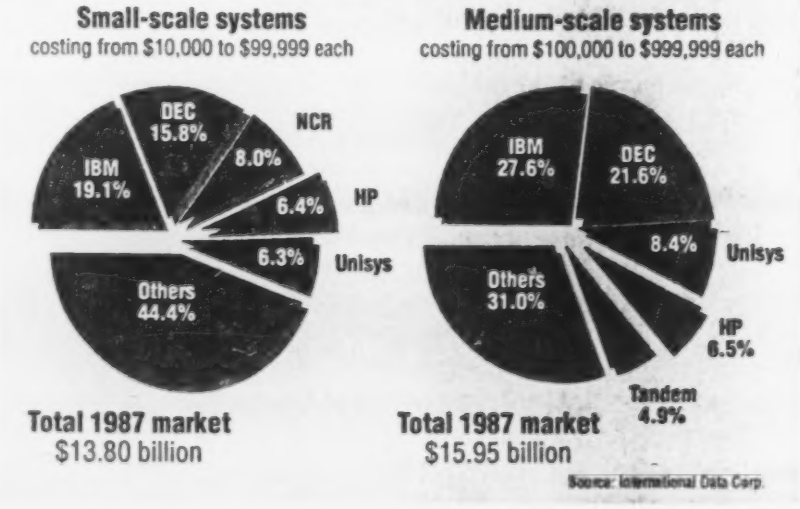
HP's share of the 1987 worldwide computer market

Value of shipments of U.S. vendors worldwide



The top R&D spenders in the electronics industry

R&D spending was up last year for the third straight year, as companies continue to accelerate their technology investments

BY DWIGHT B. DAVIS and LINDA STALLMANN

Led by the software, capital equipment and minicomputer sectors, 100 of the top U.S. electronics firms pumped 8.6% of their sales revenue into research and development during 1987. Cullinet Software Inc. paced the pack, devoting more than a quarter (28.5%) of its $174.9 million in revenue to R&D. Last year's leader, Advanced Micro Devices Inc., dropped to second place, with 24.9% of its $997.1 million in sales so committed.

Actual R&D expenditures at the 100 companies jumped from $13.0 billion in 1986 to $15.8 billion last year, a whopping 21.5% increase. This leap came despite a more modest 12.6% growth in sales, which climbed from $162.1 billion to $182.5 billion over the same period.

Driving the industry's continuing commitment to R&D have been a combination of factors, including foreign competition, increasing technological complexity and short product life cycles. "The rate of creation of new products is very high in the electronics industry," notes Todd Hixon, vice president of the Boston Consulting Group. "As a result, these companies have to spend continuously on research and development."

This analysis is seconded by Austin Mayer, director of investor relations at Sun Microsystems Inc., which ranked 14th in percentage of revenue devoted to R&D. "Our products typically have an 18 to 24 month life cycle, which means that we're constantly replacing our line," Mayer says. "We always have several generations of products under development simultaneously, which takes a lot of money and effort."

As a subset of the overall economy, electronics far surpasses most other industry sectors in its percentage of revenue spent on R&D. U.S. companies overall devoted only 3.4% of their 1987 sales revenue to R&D, according to *Business Week* magazine, or less than half the percentage of the electronics firms.

"The pure play electronics companies such as the big CPU vendors and the semiconductor firms are very committed to research and development," says analyst Hixon. "Many of the big industrial companies, on the other hand — even firms such as General Electric, that have electronics divisions — have come to the conclusion that it's better to take advantage of horizontal mergers with other companies than to invest a lot in R&D." (To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must derive at least 70% of their revenue from electronics-related sales and be included in the ELECTRONIC BUSINESS 200.)

Still, 1987 shortfalls in sales accounted for at least some of the high percentage of revenue spent at the top-ranked firms. Once R&D budgets are set and projects begun, it can be difficult to cut them back quickly, even if anticipated revenue doesn't materialize. Year-end figures may then reflect unexpectedly high percentages of revenue devoted to R&D.

AMD, for example, had planned to cut its 1987 R&D spending to about 20% of revenue, but softer than expected sales kept the percentage in the mid-20s. For 1988, however, the company is on track in its attempt to hold such spending at 20% of revenue, having cut back on some programs, such as SRAM development, and eliminated other projects entirely.

Even so, 20% spending represents far more than the industry norm, even within the relatively high-spending semiconductor sector, which devoted 9.5% of its 1987 sales to R&D. "Semiconductor companies are pursuing a technology that is not yet close to its limits," explains Hixon.

Foreign competition also plays an important role in this sector, according to AMD chairman and CEO W. Jerry Sanders III. "The U.S. microelectronics industry is in a crucial struggle to retain parity in semiconductor manufacturing with foreign competitors," he said recently, when announcing plans for a new manufacturing facility. "State-of-the-art research and development facilities are essential as the semiconductor industry moves rapidly into the submicron era."

In addition, U.S. chip makers have been forced into large R&D outlays as the lower ends of their product lines have achieved commodity

status, according to Hixon. "As the Asian companies continue to take share in the commodity end of the market, the U.S. firms must look for advances in application-specific and other high-end products."

Nevertheless, at least two factors have worked to keep semiconductor R&D spending under control. The industry's average R&D expenditures dropped from 10.6% in 1986 to 9.5% last year, in part because industry-wide sales were extremely strong in 1987, despite softness in some industry segments. The monies earmarked for R&D last year therefore ended up accounting for a smaller percentage of overall revenue.

This trend may continue in 1988, says Bob Reed, chief financial officer at 12th-ranked Intel Corp. "We're having another good year," he says, "so it's possible that the percentage of revenue spent on R&D may drop, even though we will show a healthy increase in absolute spending." Intel will spend at least $300 million this year on R&D, Reed predicts, up from $260 million last year. "The key is to keep absolute spending growing at a steady pace," he maintains.

The second factor working to ease R&D costs in the semiconductor sector is the proliferation of design automation systems and other productivity tools, according to Reed. Such products "have been a phenomenal help in holding down costs," he says. Without the consequent boost in research productivity, Reed estimates that Intel would have spent $350 million to $400 million on R&D last year, not $260 million, to achieve the same results.

Closely linked to the semiconductor sector are the capital equipment companies, many of which produce the machines and processes used to fabricate and test memory and microprocessor chips. These firms spent an average of 11.2% of revenue on R&D in 1987, placing them second only to the high-spending software segment. Applied Materials Inc., ranked at No. 4, spent well above the capital equipment industry average last year, with 17.9% of its revenue going toward R&D, but chairman and CEO James C. Morgan expects his company to approach the sector norm in coming years.

R&D spending at top electronics companies increased 21.5% despite a more modest 12.6% growth in sales

"During the industry downturn we spent very heavily on new products in the etcher, ion implant, epitaxy and CVD [chemical vapor deposition] areas," he explains. "We're now spending on technology at a run rate of about $40 million a year, and in actual dollars we expect to spend more every year. But as a percentage of sales, we expect R&D to decline to about 10% to 12%, assuming we're spending $35 million or more in absolute dollars. The nature of our business is such that if you spend something in that order of magnitude you can get a lot accomplished."

Of Applied Materials' 1,700 worldwide employees, over 200 are directly involved in research and development, Morgan says. A corporate committee of key technology executives is responsible for reviewing product development, although Morgan ultimately oversees all technology projects. "We have about three pages of things I'd like to get to," he says, "and we review the list every six months." Morgan also notes that the company works closely with its customers, "so we can leverage our R&D in that way."

However, neither the semiconductor sector nor the capital equipment companies can match the software industry when it comes to percentage of sales spent on R&D. Software firms spent a whopping 12.4% of their 1987 revenue on R&D, up from 10.1% in 1986. Some of this rise came at the expense of earnings at some of the software companies.

First-ranked Cullinet, for example, suffered a loss of $27.6 million in 1987, caused in part by the company's large commitment to R&D spending. Cullinet devoted $50 million to R&D in 1987, up from $35.5

Leaders in R&D spending

Total 1987 R&D expenditures ($ millions)

1	IBM	$5,434.0
2	Digital Equipment	1,010.4
3	Hewlett-Packard	901.0
4	Xerox	722.0
5	Unisys	597.0
6	Motorola	524.0
7	Texas Instruments	428.0
8	GM Hughes Electronics	416.0
9	Control Data	389.0
10	NCR	356.6
11	Honeywell	289.8
12	Intel	259.8
13	Advanced Micro Devices	247.8
14	National Semiconductor	218.9
15	Wang Laboratories	212.4

1987 R&D expenditures per employee

1	Apple Computer	$34,206
2	Lotus Development	27,819
3	Cray Research	25,262
4	Amdahl	23,545
5	VLSI Technology	22,698
6	Ashton-Tate	22,388
7	Applied Materials	22,193
8	Microsoft	20,967
9	Cullinet Software	20,723
10	Mentor Graphics	20,149
11	LTX	19,919
12	Digital Communications	17,775
13	Altos Computer Systems	17,646
14	3Com	16,837
15	Sun Microsystems	16,637

1987 R&D expenditures as a percentage of revenue

1	Cullinet Software	28.5%
2	Advanced Micro Devices	24.9%
3	LTX	19.2%
4	Applied Materials	17.9%
5	VLSI Technology	17.8%
6	Teradyne	16.3%
7	Cray Research	15.8%
8	Analog Devices	15.1%
9	Lotus Development	14.8%
10	Tektronix	14.3%
11	Computer Consoles	14.0%
12	Intel	13.6%
13	GenRad	13.6%
14	DSC Communications	13.1%
15	Computer Associates	13.0%

Fiscal 1987 figures

Source: ELECTRONIC BUSINESS

million the previous year. "The increase was done by intent, even though we knew it would depress our earnings," says Jeff Papous, vice president for corporate marketing.

Cullinet needed to commit additional funds to R&D, Papous explains, because the company had acquired several companies in an attempt to broaden its product line beyond the IBM mainframe marketplace. "The acquisitions accelerated our time to market," he says, "but we needed to beef up our internal R&D to make all of the new products compatible with one another and with our existing line."

Papous says Cullinet is also spending heavily in R&D because of the firm's efforts to develop applications software to supplement its traditional systems software products. Nevertheless, the company's percentage of R&D spending will drop to about 19% of revenue this year, and should hold steady at that level, he says.

Although Cullinet experienced unique pressures in 1987 that pushed its R&D spending percentage above all other electronics companies, several shared aspects of the software industry worked to keep the sector as a whole at the top of the R&D list. "In a way, software companies are almost pure product development businesses," says analyst Hixon. "Their raw materials and manufacturing costs are negligible compared to other industry sectors, and the percentage of money spent on R&D is subsequently higher."

The company profile at ninth-ranked Lotus Development Corp. supports this perspective, given that approximately one-third of the firm's employees have some R&D association, according to Ed Belove, vice president for corporate R&D. But an unrelated factor is probably responsible for the software sector's 2.3% jump in spending from 1986 to 1987, he believes.

Platform proliferation

"From 1981 to 1986, many of us in the software industry had a single platform on which to build our products: the IBM PC and its compatibles," Belove notes. "Around 1986, however, all sorts of new platforms appeared, including OS/2 and Presentation Manager-based machines, Unix workstations, the Macintosh and, for us, mainframes. During 1987, we undertook a lot of efforts to develop products for these different platforms, and our expenses, subsequently, were high."

Companies with the fastest growth in R&D spending

R&D expenditures	Percentage growth from 1986	Total 1987 ($ millions)
Genicom	143.3%	$14.9
MiniScribe	131.7%	19.8
Sun Microsystems	127.0%	69.6
Maxtor	98.3%	11.8
Micropolis	94.5%	21.8
3Com	86.7%	9.3
Microsoft	85.5%	38.1
Lotus Development	79.6%	58.4
Compaq Computer	77.1%	47.1
Intelligent Systems	70.2%	6.5
BBN	65.4%	14.3
Computer Associates	58.1%	40.1
Wyse Technology	55.6%	13.9
Western Digital	51.6%	37.4
Amdahl	50.2%	178.9

Source: ELECTRONIC BUSINESS

Lotus' 14.8% R&D spending in 1987 was "probably a bit high for us," says Belove. The company doesn't set specific spending goals for R&D as a percentage of revenue, but Belove believes 10% would be closer to the desirable level. Still, he expects that this year's spending may continue at an elevated rate, in part because customers want compatibility among all the different types of machines now installed. Achieving such compatibility will require continued heavy R&D investments, Belove predicts.

Software firms don't yet have the productivity tools to keep costs down

In addition, software companies don't yet have the productivity tools that have helped the semiconductor industry hold its costs down, points out Martyn Roetter, manager of the information and telecommunications industry practice at Arthur D. Little. "CASE [computer-aided software engineering] tools have not yet fulfilled their promise," he says. "As a result, software development is still very people-intensive."

Other electronics industry sectors, such as the peripherals, communications, components and government groups, fall below the 8.6% industry spending average, but even the lowest ranked (5.4%) government sector surpasses the 3.4% average of all U.S. businesses. The reasons why these sectors trail others in the electronics industry are varied. In the case of the defense-dependent government sector, for example, reductions in DOD expenditures have kept R&D spending down.

In other cases, subcategories of companies within sectors have bucked their sectors' overall trends. One example is that of disk drive companies within the peripherals sector. Three of the top five companies ranked by the percentage increase in revenue spent on R&D from 1986 to 1987 were disk drive manufacturers.

This jump reflects the "law of diminishing returns" in this sector, says Robert Katzive, vice president of Disk/Trend Inc. "You can spend the same amount and be late in the marketplace, or you can spend more and keep up," the market researcher says. "And this industry isn't kind to latecomers."

Technological factors have also put pressure on disk drive companies to increase sales, Katzive says, with low-end vendors shifting to the small format 3.5-inch drives and high-end suppliers packing more capacity into their products. "Drives in the 380-megabyte and above range are not easy to design [or manufacture]," he notes.

In the future, it can be expected that electronics companies of all types will continue to outpace other industry sectors in R&D outlays.

"Looking at the total R&D expenditure is too crude a measure," Roetter says. "How much is spent on basic research? How much on design engineering? How much on product engineering?" he asks.

Noting the success that Japanese firms have achieved by concentrating resources on manufacturing engineering, Roetter believes that U.S. firms need to follow suit. "It makes no sense to spend lots of money developing advanced new products if there's no way to economically manufacture them," he concludes.

Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue ($ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income ($ millions)	Percentage change in net income from 1986	Fiscal year ended
1	Cullinet	28.5%	$49.9	40.4%	$174.9	-7.6%	-$27.6	NM	4/87
2	Advanced Micro Devices	24.9%	247.8	34.8%	997.1	73.1%	-48.1	NM	12/87
3	LTX	19.2%	23.2	7.5%	120.6	26.4%	-6.7	NM	7/87
4	Applied Materials	17.9%	31.2	26.7%	174.4	16.9%	0.3	-72.9%	10/87
5	VLSI Technology	17.8%	30.5	31.0%	172.0	54.0%	8.1	14,294.6%	12/87
6	Teradyne	16.3%	61.5	21.1%	377.7	23.4%	-21.5	NM	12/87
7	Cray Research	15.8%	108.8	24.1%	687.3	15.2%	147.1	17.8%	12/87
8	Analog Devices	15.1%	56.0	23.8%	370.4	10.8%	18.7	-20.2%	10/87
9	Lotus Development	14.8%	58.4	79.6%	395.6	39.9%	72.0	49.2%	12/87
10	Tektronix	14.3%	199.6	0.7%	1,395.9	2.8%	51.2	30.2%	5/87
11	Computer Consoles	14.0%	20.8	-13.3%	148.4	14.5%	9.6	NM	12/87
12	Intel	13.6%	259.8	13.8%	1,907.1	50.8%	175.5	NM	12/87
13	GenRad	13.6%	26.4	-26.6%	193.8	-5.2%	2.1	NM	12/87
14	DSC Communications	13.1%	40.9	-11.5%	312.4	2.8%	14.6	31.9%	12/87
15	Computer Associates	13.0%	40.1	58.1%	309.3	31.9%	36.5	96.9%	3/87
16	Sun Microsystems	12.9%	69.6	127.0%	537.5	155.8%	36.3	203.8%	6/87
17	General DataComm	12.6%	25.3	29.2%	200.6	12.7%	0.8	-80.1%	9/87
18	Data General	12.5%	159.4	11.4%	1,274.3	0.5%	-82.9	NM	9/87
19	Avantek	12.3%	26.3	3.5%	213.7	2.6%	11.6	-28.0%	12/87
20	Amdahl	11.9%	178.9	50.2%	1,505.2	55.8%	142.0	261.0%	12/87
21	National Semiconductor	11.7%	218.9	-1.6%	1,867.9	26.4%	-28.8	NM	5/87
22	Digital Communications	11.6%	21.1	35.3%	181.4	31.6%	27.0	31.2%	6/87
23	Control Data	11.6%	389.0	23.9%	3,366.5	0.6%	25.0	NM	12/87
24	Prime Computer	11.4%	109.7	19.3%	960.9	11.7%	64.8	38.0%	12/87
25	Micom Systems	11.3%	22.3	40.2%	196.7	3.8%	12.2	13.2%	3/87
26	Coherent	11.3%	18.0	21.4%	159.0	15.1%	-1.1	NM	9/87
27	Cipher Data Products	11.3%	20.1	33.3%	178.2	9.3%	4.3	-39.8%	6/87
28	Hewlett-Packard	11.1%	901.0	9.3%	8,090.0	13.9%	644.0	24.8%	10/87
29	Apollo Computer	11.0%	61.1	36.9%	553.7	41.4%	21.7	132.5%	12/87
30	LSI Logic	11.0%	28.9	34.1%	262.1	34.9%	10.7	178.8%	12/87
31	Microsoft	11.0%	38.1	85.5%	345.9	75.1%	71.9	83.1%	6/87
32	Mentor Graphics	10.9%	24.2	43.9%	221.8	27.9%	20.3	84.8%	12/87
33	Fluke	10.8%	22.2	-7.8%	206.3	-1.5%	2.0	-83.5%	9/87
34	Digital Equipment	10.8%	1,010.4	24.1%	9,389.4	23.7%	1,137.4	84.2%	6/87
35	Intergraph	10.5%	67.5	16.9%	641.1	5.8%	69.9	-0.7%	12/87
36	Perkin-Elmer	10.5%	140.2	33.5%	1,333.6	3.3%	-18.2	NM	7/87
37	Tandem Computers	10.5%	108.5	25.2%	1,035.5	34.9%	105.6	65.6%	9/87
38	Ashton-Tate	10.5%	28.0	43.5%	267.3	26.8%	43.1	43.1%	1/88
39	Stratus Computer	10.3%	18.9	34.0%	184.2	47.8%	19.4	43.5%	12/87
40	Gould	10.1%	94.3	-3.7%	933.4	2.7%	25.0	-27.7%	12/87
41	IBM	10.0%	5,434.0	36.7%	54,217.0	5.8%	5,258.0	9.8%	12/87
42	Westmark International	9.6%	28.0	17.9%	291.9	19.8%	-7.2	NM	12/87
43	Quantum	9.5%	11.5	1.8%	120.8	-0.4%	8.8	-60.4%	3/87
44	ADC Telecommunications	9.3%	15.5	19.2%	166.9	16.1%	15.3	27.5%	10/87
45	Applied Magnetics	9.2%	19.5	14.9%	211.9	65.4%	14.2	246.6%	9/87
46	Dynatech	9.0%	27.3	23.7%	304.7	18.7%	23.2	13.5%	3/87
47	Altos Computer Systems	9.0%	13.8	27.9%	153.9	14.7%	9.7	-52.3%	6/87
48	AMP	8.8%	204.0	20.0%	2,317.8	19.9%	249.7	51.9%	12/87
49	TIE/communications	8.6%	21.4	-6.2%	250.2	-16.1%	-11.1	NM	12/87
50	3Com	8.4%	9.3	86.7%	110.4	72.5%	11.1	66.8%	5/87

NM = Not meaningful. The company lost money in the base year

(Continued)

Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue ($ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income ($ millions)	Percentage change in net income from 1986	Fiscal year ended
51	Medtronic	8.4%	$42.1	9.3%	$502.0	24.6%	$73.8	9.5%	4/87
52	ISC Systems	8.4%	14.1	-5.2%	168.5	1.5%	6.5	-52.9%	6/87
53	Varian Associates	8.2%	80.7	-1.9%	982.8	10.3%	21.4	NM	9/87
54	Paradyne	8.2%	19.0	-2.4%	232.6	-10.9%	-2.6	NM	12/87
55	Western Digital	8.1%	37.4	51.6%	462.5	65.5%	42.8	99.2%	6/87
56	Storage Technology	8.0%	60.1	-3.3%	750.0	7.8%	19.0	12.8%	12/87
57	Motorola	7.8%	524.0	6.5%	6,707.0	13.9%	308.0	58.8%	12/87
58	Texas Instruments	7.7%	428.0	5.4%	5,594.5	12.5%	256.9	543.9%	12/87
59	Micropolis	7.5%	21.8	94.5%	288.3	35.2%	27.2	49.3%	12/87
60	Wang Laboratories	7.5%	212.4	4.7%	2,836.7	7.3%	70.7	38.9%	6/87
61	Gerber Scientific	7.4%	16.6	-7.2%	223.9	16.7%	21.1	15.8%	4/87
62	Measurex	7.3%	16.7	18.3%	227.4	18.0%	26.8	27.3%	11/87
63	Apple Computer	7.2%	191.6	49.9%	2,661.1	39.9%	217.5	451.7%	9/87
64	Xerox	7.0%	722.0	11.1%	10,320.0	10.3%	578.0	18.4%	12/87
65	Diasonics	6.9%	18.5	35.4%	267.6	23.2%	15.2	NM	12/87
66	Aydin	6.7%	10.0	32.4%	149.2	9.1%	8.8	26.6%	12/87
67	Maxtor	6.7%	11.8	98.3%	175.3	105.9%	22.4	109.5%	3/87
68	Dataproducts	6.6%	22.4	-27.9%	338.8	-4.3%	9.0	NM	3/87
69	Watkins-Johnson	6.4%	16.9	4.2%	264.3	3.5%	17.1	-0.7%	12/87
70	NCR	6.3%	356.6	11.2%	5,640.7	15.5%	419.3	24.6%	12/87
71	Veeco Instruments	6.2%	12.2	-1.4%	195.6	16.6%	9.2	2,328.2%	9/87
72	Datapoint	6.2%	19.4	-14.4%	312.1	-4.0%	-58.5	NM	7/87
73	Unisys	6.1%	597.0	35.4%	9,712.9	30.7%	578.0	NM	12/87
74	Bolt Beranek and Newman	6.1%	14.3	65.4%	233.8	31.3%	-8.0	NM	6/87
75	Oracle Systems	6.0%	7.9	12.9%	131.3	137.0%	15.6	165.0%	5/87
76	Cherry Electrical Products	6.0%	9.6	11.1%	160.6	24.2%	2.7	NM	2/87
77	Harris	5.7%	118.0	0.1%	2,079.0	-6.2%	84.5	41.8%	6/87
78	Decision Industries[1]	5.7%	10.9	6.4%	191.4	-1.9%	-20.4	NM	11/87
79	M/A-COM	5.6%	24.5	-28.0%	436.1	-24.5%	-29.3	NM	9/87
80	Molex	5.5%	21.2	23.6%	386.8	32.5%	43.4	35.5%	6/87
81	MiniScribe	5.5%	19.8	131.7%	362.5	96.0%	28.1	38.8%	12/87
82	AST Research	5.4%	11.1	32.1%	206.0	19.5%	13.0	-52.0%	6/87
83	Wyse Technology	5.3%	13.9	55.6%	260.0	56.2%	18.1	44.1%	3/87
84	International Rectifier	5.3%	8.1	-12.5%	151.8	4.6%	-17.2	NM	6/87
85	Augat	5.1%	16.1	-3.6%	313.2	20.4%	11.5	NM	12/87
86	Genicom	4.9%	14.9	143.3%	302.2	91.9%	12.6	45.9%	12/87
87	Sprague Technologies	4.8%	20.8	-6.7%	437.3	-2.6%	3.6	NM	12/87
88	Litton Industries	4.7%	209.7	-18.3%	4,419.7	-2.2%	138.1	94.3%	7/87
89	Kollmorgen	4.7%	14.2	-14.6%	301.0	-5.7%	0.3	NM	12/87
90	Andrew	4.7%	10.4	-21.7%	223.2	12.9%	3.8	-59.9%	9/87
91	Esterline	4.7%	12.1	6.1%	259.7	10.1%	-29.3	NM	10/87
92	Loral	4.6%	32.0	3.3%	690.0	4.0%	57.5	8.4%	3/87
93	Recognition Equipment	4.4%	11.6	0.3%	264.7	9.5%	11.2	6.4%	10/87
94	Zenith Electronics	4.4%	103.4	3.7%	2,362.7	24.9%	-19.1	NM	12/87
95	Honeywell	4.3%	289.8	17.5%	6,679.3	24.2%	253.7	1,866.7%	12/87
96	Scientific-Atlanta	4.1%	20.1	-27.1%	495.3	5.6%	24.3	NM	6/87
97	MAI Basic Four	4.0%	12.9	-16.0%	321.0	14.2%	22.8	34.9%	9/87
98	Intelligent Systems	4.0%	6.5	70.2%	163.2	30.0%	10.2	540.6%	12/87
99	GM Hughes Electronics	4.0%	416.0	1.9%	10,481.0	0.4%	521.1	17.1%	12/87
100	Compaq Computer	3.8%	47.1	77.1%	1,224.1	95.8%	136.3	217.7%	12/87

NM = Not meaningful. The company lost money in the base year
[1] Decision Industries went private April 29, 1988

Source: ELECTRONIC BUSINESS

Top R&D spenders by industry segment

Fiscal 1987 figures

Minicomputers

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
IBM	$5,434.0	10.0%	$13,957
Digital Equipment	$1,010.4	10.8%	$9,144
Hewlett-Packard	$901.0	11.1%	$10,988
Data General	$159.4	12.5%	$10,163
Prime Computer	$109.7	11.4%	$12,439
Tandem Computers	$108.5	10.5%	$15,481
Gould	$94.3	10.1%	$9,313
Sun Microsystems	$69.6	12.9%	$16,637
Apollo Computer	$61.1	11.0%	$15,285
Computer Consoles	$20.8	14.0%	$16,144
Stratus Computer	$18.9	10.3%	$15,449
MAI Basic Four	$12.9	4.0%	$3,960
Segment total	**$8,000.7**	—	—
Segment averages	—	**10.3%**	**$12,551**

Mainframes

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
IBM	$5,434.0	10.0%	$13,957
Unisys	$597.0	6.1%	$6,454
Control Data	$389.0	11.6%	$11,275
NCR	$356.6	6.3%	$5,752
Amdahl	$178.9	11.9%	$23,545
Cray Research	$108.8	15.8%	$25,262
Segment total	**$7,064.4**	—	—
Segment averages	—	**9.4%**	**$11,968**

Office equipment

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
IBM	$5,434.0	10.0%	$13,957
Xerox	$722.0	7.0%	$7,293
NCR	$356.6	6.3%	$5,752
Wang Laboratories	$212.4	7.5%	$7,009
Harris	$118.0	5.7%	$4,856
Pitney Bowes	$65.1	2.9%	$2,210
Datapoint	$19.4	6.2%	$7,046
Diebold	$14.3	3.3%	$2,938
Savin	$4.6	1.3%	$2,272
Segment total	**$6,946.4**	—	—
Segment averages	—	**8.9%**	**$10,785**

Microcomputers

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
IBM	$5,434.0	10.0%	$13,957
Apple Computer	$191.6	7.2%	$34,206
Zenith Electronics	$103.4	4.4%	$2,954
Compaq Computer	$47.1	3.8%	$11,776
Atari	$18.0	3.7%	$4,412
Altos Computer	$13.8	9.0%	$17,646
AST Research	$11.1	5.4%	$8,186
Tandon	$10.3	3.6%	$2,938
Segment total	**$5,829.3**	—	—
Segment averages	—	**9.5%**	**$13,138**

Government

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Motorola	$524.0	7.8%	$5,363
Texas Instruments	$428.0	7.7%	$5,488
GM Hughes Electronics	$416.0	4.0%	$4,160
Honeywell	$289.8	4.3%	$3,674
Litton Industries	$209.7	4.7%	$3,869
Harris	$118.0	5.7%	$4,856
Gould	$94.3	10.1%	$9,313
Varian Associates	$80.7	8.2%	$6,784
Singer	$38.4	2.0%	$1,371
E-Systems	$33.7	2.7%	$2,173
Loral	$32.0	4.6%	$2,203
Watkins-Johnson	$16.9	6.4%	$5,414
Aydin	$10.0	6.7%	$5,023
Cubic	$5.2	1.4%	$1,164
Logicon	$1.6	0.8%	$643
Segment total	**$2,298.4**	—	—
Segment averages	—	**5.4%**	**$4,376**

Semiconductors

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Motorola	$524.0	7.8%	$5,363
Texas Instruments	$428.0	7.7%	$5,488
Intel	$259.8	13.6%	$13,531
Advanced Micro Devices	$247.8	24.9%	$13,755
National Semiconductor	$218.9	11.7%	$7,497
Harris	$118.0	5.7%	$4,856
Gould	$94.3	10.1%	$9,313
Analog Devices	$56.0	15.1%	$10,777
Western Digital	$37.4	8.1%	$11,204
VLSI Technology	$30.5	17.8%	$22,698
LSI Logic	$28.9	11.0%	$12,465
International Rectifier	$8.1	5.3%	$3,429
Segment total	**$2,051.7**	—	—
Segment averages	—	**9.5%**	**$7,049**

Capital equipment

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Hewlett-Packard	$901.0	11.1%	$10,988
Tektronix	$199.6	14.3%	$11,676
Perkin-Elmer	$140.2	10.5%	$9,929
Varian Associates	$80.7	8.2%	$6,784
Teradyne	$61.5	16.3%	$13,089
Applied Materials	$31.2	17.9%	$22,193
GenRad	$26.4	13.6%	$12,484
LTX	$23.2	19.2%	$19,919
John Fluke	$22.2	10.8%	$9,258
Gerber Scientific	$16.6	7.4%	$9,229
Esterline	$12.1	4.7%	$3,834
Sun Electric	$5.0	2.4%	$2,035
Segment total	**$1,519.7**	—	—
Segment averages	—	**11.2%**	**$10,532**

(Continued)

Top R&D spenders by industry segment

Fiscal 1987 figures	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Computer-based systems			
Hewlett-Packard	$901.0	11.1%	$10,988
Honeywell	$289.8	4.3%	$3,674
Intergraph	$67.5	10.5%	$10,710
Coherent	$18.0	11.3%	$11,106
Measurex	$16.7	7.3%	$6,578
Gerber Scientific	$16.6	7.4%	$9,229
ISC Systems	$14.1	8.4%	$7,898
Recognition Equipment	$11.6	4.4%	$3,990
Sun Electric	$5.0	2.4%	$2,035
Segment total	**$1,340.3**	—	—
Segment averages	—	**8.0%**	**$7,434**
Communications			
Motorola	$524.0	7.8%	$5,363
DSC Communications	$40.9	13.1%	$16,076
Dynatech	$27.3	9.0%	$8,818
Avantek	$26.3	12.3%	$8,651
General DataComm	$25.3	12.6%	$9,574
General Instrument	$24.7	3.1%	$1,517
M/A-COM	$24.5	5.6%	$3,624
Micom Systems	$22.3	11.3%	$10,924
TIE/communications	$21.4	8.6%	$14,298
Digital Communications	$21.1	11.6%	$17,775
Scientific-Atlanta	$20.1	4.1%	$5,999
Paradyne	$19.0	8.2%	$6,095
ADC Telecommunications	$15.5	9.3%	$8,615
Bolt Beranek and Newman	$14.3	6.1%	$5,352
Andrew	$10.4	4.7%	$4,528
Aydin	$10.0	6.7%	$5,023
3Com	$9.3	8.4%	$16,837
Dynascan	$1.6	0.8%	$4,145
Segment total	**$858.0**	—	—
Segment averages	—	**7.5%**	**$5,609**
Peripherals			
Control Data	$389.0	11.6%	$11,275
Storage Technology	$60.1	8.0%	$6,776
Seagate Technology	$33.6	3.5%	$2,097
Dataproducts	$22.4	6.6%	$5,731
Micropolis	$21.8	7.5%	$9,124
Cipher Data Products	$20.1	11.3%	$10,683
MiniScribe	$19.8	5.5%	$3,988
Applied Magnetics	$19.5	9.2%	$2,807
Genicom	$14.9	4.9%	$4,163
Wyse Technology	$13.9	5.3%	$6,863
Maxtor	$11.8	6.7%	$6,109

Continued next column

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Peripherals (continued)			
Xidex	$11.6	2.0%	$1,679
Quantum	$11.5	9.5%	$16,522
Decision Industries	$10.9	5.7%	$7,027
Tandon	$10.3	3.6%	$2,938
Intelligent Systems	$6.5	4.0%	$13,235
Segment total	**$688.6**	—	—
Segment averages	—	**7.9%**	**$6,786**
Components			
AMP	$204.0	8.8%	$9,273
Molex	$21.2	5.5%	$4,264
Sprague Technologies	$20.8	4.8%	$2,414
Augat	$16.1	5.1%	$4,237
Cherry Electrical	$9.6	6.0%	$3,333
AVX	$8.4	3.1%	$1,120
CTS	$5.3	2.0%	$798
BRIntec	$4.5	1.5%	$1,152
Oak Industries	$4.0	2.2%	$1,046
Segment total	**$293.9**	—	—
Segment averages	—	**6.4%**	**$4,581**
Software			
Lotus Development	$58.4	14.8%	$27,819
Cullinet Software	$49.9	28.5%	$20,723
Computer Associates	$40.1	13.0%	$14,853
Microsoft	$38.1	11.0%	$20,967
Ashton-Tate	$28.0	10.5%	$22,388
Mentor Graphics	$24.2	10.9%	$20,149
Oracle Systems	$7.9	6.0%	$7,026
Ultimate	$4.5	2.6%	$10,000
Segment total	**$251.1**	—	—
Segment averages	—	**12.4%**	**$19,244**
Medical			
Medtronic	$42.1	8.4%	$8,504
Westmark International	$28.0	9.6%	$9,267
Diasonics	$18.5	6.9%	$12,243
Segment total	**$88.6**	—	—
Segment averages	—	**8.3%**	**$9,342**

Segment R&D as a percentage of revenue averages are weighted

Source: ELECTRONIC BUSINESS

Misadventures in AI: What went wrong at Symbolics

Not-so-smart marketing may have downed the Cambridge, Mass., manufacturer of smart machines. Some say a comeback won't be easy

BY ANDREA COHEN

Perched above the receptionist's desk in the lobby of Symbolics Inc. are several pink plastic flamingos. But the frivolous decor is far from indicative of the scrambling going on inside the offices of this Cambridge, Mass., firm.

Industry analysts say the story of Symbolics is a classic case of a technology-driven company which lost — or perhaps never truly found — a suitable marketing direction. The artificial intelligence (AI) pioneer did not foresee the obstacles in transcending its traditional customer base of high-end R&D labs, universities and other more sophisticated users. It was slow in recognizing customers' preferences for software standards such as Unix. And the threat posed by general workstations and personal computers was sorely underestimated.

Indeed, Symbolics is not alone in its misfortunes. One of its hardware competitors, Lisp Machines Inc., declared bankruptcy last year; and other AI software pioneers, such as Intellicorp and Teknowledge Inc., are probably disappointed that the AI software market has not developed as rapidly as some analysts had once predicted. Such difficulties are the result of the AI market's shift from expensive, specialized computers which run AI applications, to software which can be run on the standard computers — personal computers, minis and mainframes — which are already present in many busineses.

The market for high-end users was quickly saturated, leaving the less specialized market open. Such customers, by using more traditional computers, are able to forego the expense of buying specialized hardware and hiring specialized programmers trained to run Lisp, the symbolic-processing language. Thus, the focus has since turned from special purpose hardware to broadbased hardware — traditional workstations like those made by Apollo Computer Inc., Digital Equipment Corp. and Sun Microsystems Inc.

"I don't think anyone realized a couple years ago that at this point you could be approaching the ability to run fairly advanced AI applications, if not development, on even traditional PCs," remarks Symbolics' assistant general counsel, Francis Feeney. The company has made efforts to cut costs and to orient itself around today's AI market needs, but so far without any striking results.

When it was founded in 1980 by engineers and scientists from the Massachusetts Institute of Technology's Artificial Intelligence Laboratory, the company reaped the benefits of its technological excellence in a new technology. Annual revenue climbed from $40.7 million in fiscal 1984 to $69 million in 1985, and all the way up to $114 million in fiscal 1986, ended June 30. And net income rose too: from $1 million in 1984 to nearly $11 million in fiscal 1986.

President Ronald Derry: Down the line, Symbolics' commitment to software and hardware should shift more strongly toward software

Dave Bradley

PC impact

Success evidently went to Symbolics' corporate head. In June of 1986, the company moved from its crowded offices in Cambridge to a new world headquarters among the lush hills and meadows of Concord, Mass., and more employees were hired — just as the AI market began to lose its sparkle.

Six months later, reality set in. To cut costs, Symbolics moved everyone back to the then even more crowded Cambridge location — a move that is perhaps the best watershed in gauging Symbolics' early successes against its difficulties in the past year and a half. Since then, the company has suffered vastly diminished earnings, struggles in upper management, large reductions in workforce, losses and more losses.

For fiscal 1987, income gave way to losses of over $25 million. Recent quarters have shown scant improvement: the three months ended January 3 produced $15.4 million in net losses, with the April quarter closing $4.9 million in the red.

In January of this year, 10% of the company's 730-member workforce was laid off. Then in May, 35% of the remaining staff was bid adieu in order to, as Symbolics' president Ronald L. Derry says, ensure profitability and "to put ourselves in a position where we reduce our costs until a new set of products can hopefully

allow us to expand into new markets."

In February of this year, Derry replaced Brian Sear, who, according to Howard Cannon, a Symbolics cofounder and product director for PC products, "had more of an emphasis on the workstation end of the business, and recently it's become clear that engineering and building our own workstation was not the best way for Symbolics to succeed."

Ill-starred ambition

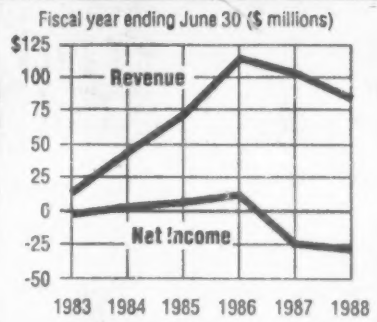
Harvey Newquist, editor of *AI Trends*, a newsletter based in Scottsdale, Ariz., suggests Symbolics may have been overly ambitious. He claims that the company wasn't content being a $100 million a year company and instead "at times felt that it could take on the installed base of normal machines or take on large workstation companies like Sun and Apollo, [which] gave them illusions of grandeur so that they spread into places they really had no business being."

Although most observers agree that the company has never suffered from a lack of technical expertise, such talent has not been adequately matched with marketplace savvy. Feeney says: "When we were growing so quickly here internally, I don't think anybody stopped and said, 'Well, wait a minute, once we saturate that fixed market . . . is there going to be a [broader] market for our system?' "

Feeney adds that Symbolics executives underestimated the problems posed by the fact that although "the sophisticated user has no sort of qualms about getting a different box, a Symbolics box [as opposed to] an IBM or a DEC box," more traditional users are not interested in nonconventional systems.

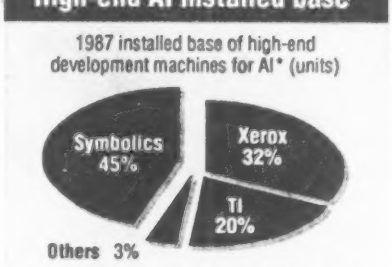
One customer that seems happy with Symbolics, for example, is MCI International, which is using the Symbolics 3620 model to develop an application involving an automated money transfer service. While there are indications that MCI is concerned about the financial stability of Symbolics, it has had no major problems with the machines. Nevertheless, MCI is reportedly evaluating DEC workstations and some PCs based on Intel Corp.'s 80386 and Motorola Inc.'s 68000 series microprocessors to do similar sorts of applications.

Symbolics' sales and income



Sources: Company reports; estimates from Arnhold and S. Bleichroeder Inc.

High-end AI installed base



Total 1987 installed base: 8,000 units

* Excludes internal distribution

Source: Hambrecht & Quist Inc.

Although Symbolics has the highest market share for high-end AI machines, PCs and general workstations have made sizable inroads in the AI field

Symbolics is presently following several routes in order to redefine its market niche. Cofounder Cannon remarks that Symbolics is more interested now in "plugging into those boxes — which other people can build more efficiently — as opposed to building them." One year after its projected shipping date, the company is finally preparing to unveil its Ivory Processor, an embedded package for Apple's Macintosh II machine. The product, due to be shipped by the end of this year, uses Symbolics' Ivory chip, which contains a symbolic processor.

Embarrassingly though, by missing its market window, Symbolics was beaten to the punch by Texas Instruments Inc. In April, TI began shipping its MicroExplorer, a system comprised of a Mac II and a Lisp microprocessor resident on a coprocessor board. Cannon defends Symbolics' late entry, reasoning that TI's model is based on an already existing architecture, whereas Symbolics' version uses a new VLSI implementation.

According to Cannon, Symbolics' R&D labs are particularly working on adding increased capabilities in the form of layered products that customers can add to Genera, Symbolics' operating system software. One product — Statice, an object-oriented database system — has been announced already. Also recently introduced is Cloe (Common Lisp Operating Environment), a layered software package which allows development on a Symbolics system with delivery onto 386-based platforms.

Symbolics is also moving toward more standard hardware. In May, the company announced a deal with Sony Microsystems Co. which enables it to act as a reseller for Sony workstations and as Sony's third-party service arm in the United States. According to Thomas Farb, Symbolics' vice president for finance, this will allow the company's customers the convenience of purchasing Unix workstations from them.

AI market analyst Newquist admits to being "completely baffled" about the agreement. "I think the company is so embedded in its hardware and manufacturing roots that it finds it almost impossible to extricate that from its mindset. I really think that they will not end up keeping the hardware side," he predicts.

However, Farb is adamant: "By no means are we abandoning our hardware." Derry maintains that commitment to software and hardware will be pretty much equal in the immediate future, but down the line, should shift more strongly toward software.

The next year should reveal whether or not Symbolics' staff cuts, product plans and market realignment constitute effective enough damage control. Caution is clearly the watchword in the Symbolics boardroom: executives will not commit openly to a target date for a return to profitability. If things do turn around, those pink flamingos in the lobby may get the last laugh. Otherwise, another model of a bird which hangs from a ceiling in an upper hallway of the Cambridge offices might be a more accurate company mascot. That one's a pterodactyl. □

A detailed look at Japan's AI market

According to a recently published survey, the majority of computer hackers in Japan have already begun trial usage of expert systems

BY SHOHEI KURITA

Artificial intelligence in Japan is slowly, but surely, coming of age. In fact, Japan's demand for AI software will reach $7.7 billion in 1990 and accelerate to $38.4 billion by 1995, predicts a government agency there.

But market figures alone do not tell the whole story. The results from a recent survey conducted by the Japan Information Processing Development Center (JIPDEC) reveal detailed information — published in Japanese last June and translated for ELECTRONIC BUSINESS — about the country's growing AI sophistication. JIPDEC surveyed 1,025 advanced computer users in Japan; 323 companies and organizations responded for a substantial 31.5% reponse rate.

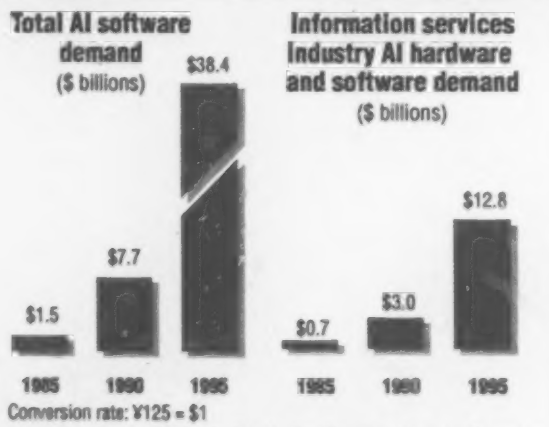
The survey indicates that 55% of Japan's advanced computer users have already begun at least trial usage of an expert system. And nearly 40% indicated that within three years, they would be employing such software for everyday usage. The primary benefit of expert systems — defined as computers with the problem-solving capabilities of human experts — is productivity improvement. For example, Digital Equipment Corp. in Japan uses a number of expert systems in order to streamline the company's operations there [see accompanying story].

The companies surveyed reported that they allocated an average 7% of their entire software development personnel to AI systems development in 1987. Five years later, the companies expect the figure to rise to 21%. The public service related industries — including construction, public utilities, transportation and communications — will be among the leaders in using AI. Companies in such industries expect that 29% of their software personnel will be involved in AI in 1992.

Of the more than 400 expert systems used by the survey's respondents, failure diagnosis was the leading application, with a 31% share. Following that were systems used for planning, 16%; designing, 15%; instruction, 8%; prediction, 6%; data interpretation, 5%; system control, 5%; debugging, 3%; and other miscellaneous applications, 11%. About 59% of all expert systems are used solely in house while 23% are developed with the intent to sell them on the open market. The remaining 18% consists of systems that are developed for in-house usage but which might have a limited market.

According to the survey, Fujitsu Ltd. ranked as the No. 1 vendor of AI "shells," the software framework around which expert systems are written. Almost a quarter of the respondents who use a software shell said they use Fujitsu's ESHELL. The Tokyo-based firm reports that 53% of ESHELL users are manufacturing companies. Universities and research institutes were second in ESHELL us-

Japan's demand for AI

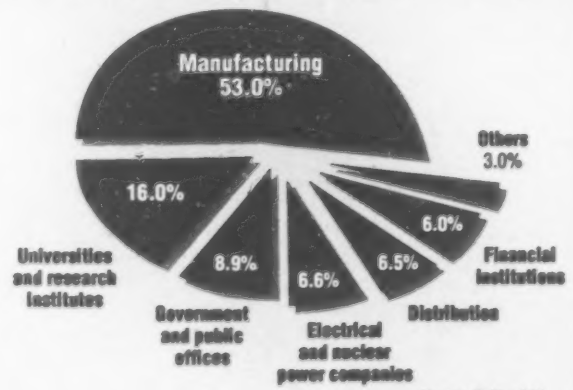


Conversion rate: ¥125 = $1

Source: Institute for New Generation Computer Technology

Who uses AI in Japan?

Survey of Fujitsu ESHELL users (as of October 1987)



Source: Fujitsu Ltd.

age, accounting for 16% of the units sold.

IntelliCorp of Mountain View, Calif., with its Knowledge Engineering Environment (KEE) product, also fared well in the JIPDEC survey. Ten percent of the respondents who had developed their own expert systems said they had done so using KEE.

As far as hardware goes, computers used for expert system development in Japan are comprised of mainframes, 22%; minicomputers, 7%; engineering workstations, 18%; personal computers, 28%; and AI-dedicated machines, 25%. For delivery vehicles used by AI customers, mainframes make up 23%; minicomputers, 6%; workstations, 22%; personal computers, 30%; and 19% by AI-dedicated machines such as the Personal Sequential Inferencecomputer designed by the Institute of New Generation Computer Technology (ICOT). Mitsubishi Electric Corp. sells a licensed commercialized version of the machine.

Hardware from U.S. manufacturers Symbolics Inc. of Cambridge, Mass., and Dallas-based Texas Instruments Inc. also fared well in the survey. In fact, Symbolics has shipped approximately 300 systems thus far in Japan. TI sells its Explorer AI workstations through C. Itoh & Company Ltd.

While expert systems have dominated Japan's AI scene, other applications are currently coming to the fore. The JIPDEC survey indicates that trial usage of image or graphic recognition systems, voice recognition systems, intelligent robots, automatic programming systems and intelligent man-machine interfaces will peak in roughly three years. Real usage of such systems will take five years to reach a plateau, except in the robotic arena, which will take 10 years, reflecting the difficulty of incorporating AI in that field.

Another area of rampant AI activity is in foreign language translation systems, where Japan boasts a worldwide technological lead, according to many industry gurus. The country's Center of the International Cooperation for Computerization — charged by the government to develop a multilingual machine translation system — has sponsored a project involving the governments of China, Indonesia, Malaysia and Thailand.

For the project, Fujitsu, Hitachi Ltd., Mitsubishi Electric, NEC Corp., Oki Electric Industry Company Ltd., Sharp Corp. and Toshiba Corp. are cooperating to develop an intermediate language that will be used to translate Japanese into Chinese, Indonesian, Malay and Thai and vice versa. The Japanese government has allocated roughly $48 million for the project, which should reach completion by 1993. □

Editor's note: an exchange rate of $1 = ¥125 was used.

How DEC puts AI to work in Japan

The following is an excerpt from a speech given by Gen Narui, director of educational services for Nihon Digital Equipment Corp., DEC's Tokyo-based subsidiary. Narui was one of the featured speakers at a seminar on the Japanese electronics industry, cosponsored by the American Electronics Association and ELECTRONIC BUSINESS *and held in Osaka, Japan.*

We use an expert system called Xsel to help our salesmen put together quotations for computer equipment. Our salesmen feed in customer requirements and Xsel determines the most appropriate system. After a salesman writes up a purchase order, we use another expert system, Xcon, to check the order accuracy. Before Xcon was developed, a group of technical editors did this job. They took an average of 30 minutes to check orders and were only about 70% accurate. Now, Xcon makes the checks in two to three minutes and is 98% accurate.

At our factory, we use another expert system, CDS, to determine whether the hardware configuration on the order actually runs. And, in the event that a customer cancels an order, we use a program called Matcher to reassign equipment already in production to other orders. It determines which components must be changed to transform a canceled computer into the configuration a different customer needs.

Our salesmen use an expert system for quoting prices

A program called ND keeps deliveries in line with orders. And another program, Xsite, determines the preparation that must take place at the customer site before new equipment can be installed. And, since many of our computers contain communication devices that feed data into our maintenance centers, we use an expert sytem, AIspear, to anticipate problems at the centers. The program monitors customer data and can predict common problems before equipment actually malfunctions. If equipment does go down, the program tells our engineers what spare parts to take on the repair call.

In Japan, our customers are using expert systems for a variety of purposes. For example, one of the country's largest department stores uses an expert system to streamline its purchasing operations.

Finally, AI can help differentiate products by giving them unique or unusual features. For example, some Japanese word-processing programs stand out from the competition because they incorporate AI. Often, two or more words in Japanese have the same phonetic spelling — as do the English words "hot," meaning very warm, and "hot," meaning spicy. The word processor uses AI techniques to analyze the sentence in question and pick the correct character.

GEN NARUI

Smart sensors play a role in the U.S./Japan auto war

Makers are eyeing a vast new market for "smart" devices that turn "dumb" heaps of metal into intelligent driving machines

BY MICHAEL R. LEIBOWITZ

Dashboards don't look like they used to. Glitzy multicolored arrays instantly alert the driver when something goes wrong. Under the hood, temperature, pressure, speed, flow, position and acceleration are scrupulously monitored. The data is relayed to on-board computers which optimize engine performance.

Sensors make this possible. And now a new generation of devices is turning otherwise "dumb" heaps of metal and components into "smart" cars. Sensors are the eyes, ears and nose of today's vehicles. Sensors first became important for measuring emissions and have spread through the car to keep the brakes from locking, control an auto's suspension and trigger air bags to inflate. In the engine alone, 15 sensors measure everything from manifold pressure to air flow temperature.

Indeed, the dawning of the high-tech automobile has created a veritable gold mine of potential sensor applications and perhaps the biggest opportunity the sensor industry has seen in years. Thank the Japanese for the newfound opportunities. In shaking Detroit out of its competitive slumber, they have created a war that is being fought on slick auto features that require sensors. As a result, the numbers are staggering. Take 33 million cars shipped each year and multiply that by 150 new and planned sensor applications and you get an idea of the potential. Simply put, the more electronics that a car uses, the more need for sensors to tell the computer what is going on.

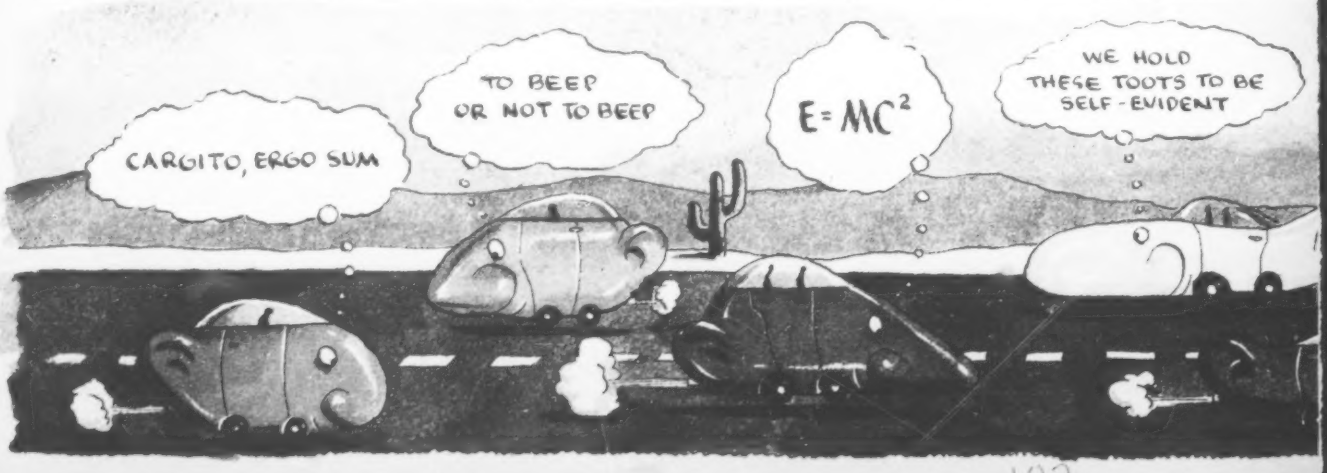
Automakers will buy almost $2 billion in engine and power train sensors this year

U.S. and foreign automakers will buy $1.97 billion worth of engine and power train sensors for the U.S. market this year, up from $1.81 billion last year, according to Venture Development Corp., a Natick, Mass., market research firm. Sales are expected to grow 6% annually for the next four years. Meanwhile, the real bonanza of sensor business in coming years will be for new, nonengine applications. Demand for other electronic and electromechanical sensors to make cars safer and easier to use will grow about 17% a year in the same period, from $727 million this year to $1.38 billion in 1992.

Largest sensor application

It's no wonder that suppliers are tripping over themselves to get or expand their pieces of the action. Production volumes are tremendous, according to Janusz Bryzek, chief executive and cofounder of Novasensor, a Milpitas, Calif., sensor start-up. Automobiles, he says, represent "the largest application for sensors today."

Major U.S. sensor makers include General Motors Corp.'s Delco Electronics Division, Honeywell Inc.'s Microswitch Division, United Technologies Corp. and dozens of smaller companies such as Novasensor. Japan's Hitachi Ltd. and Nippondenso and West Germany's Robert Bosch GmbH also are important players. While GM/Delco reportedly heads the list, there is no one dominant supplier. "There's a million different

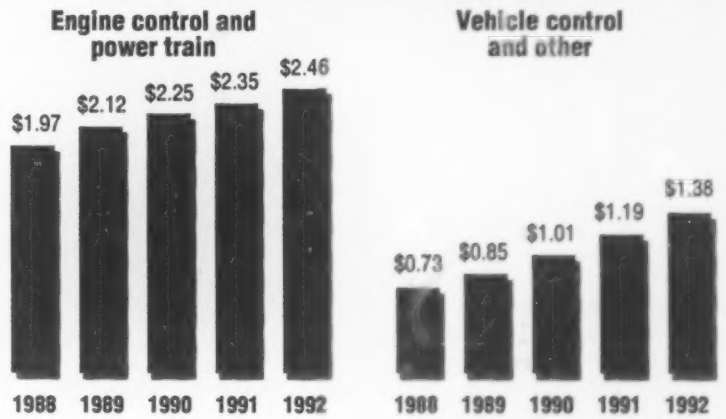


FOURTH IN A SERIES

As auto companies in the United States and Japan race to build the car of the future, sophisticated electronics technology is playing an increasingly important role. This story, the fourth in our series on automotive electronics, focuses on the expanding role of sensors in car design.

U.S. auto sensor market

Consumption of automotive sensors by manufacturers of passenger cars for the U.S. market ($ billions)



Source: Venture Development Corp.

technologies" used for auto sensors now, explains Joseph Giachino, supervisor for sensor development at Ford Motor Co., making it difficult for any single company to gain a monopoly.

In fact, the shift to new sensor technologies is what is providing many smaller sensor makers with an entree into the automobile market. Automakers are shifting from electromechanical sensors to more reliable, and in some cases less expensive, solid-state sensors and micro-machined sensors. Solid-state sensors rely on electrical changes induced in a material by such things as pressure, temperature and the position of a magnet. Micro-machined sensors, or silicon microstructures, are actually tiny electromechanical devices for measuring forces such as pressure, air flow and acceleration. Their parts are fabricated from silicon in a process similar to that in which integrated circuits are made. Currently, about 60% to 65% of all auto sensors today are electronic and the remainder electromechanical, according to Market Intelligence Research Co. of Palo Alto, Calif. But the shift to electronics continues.

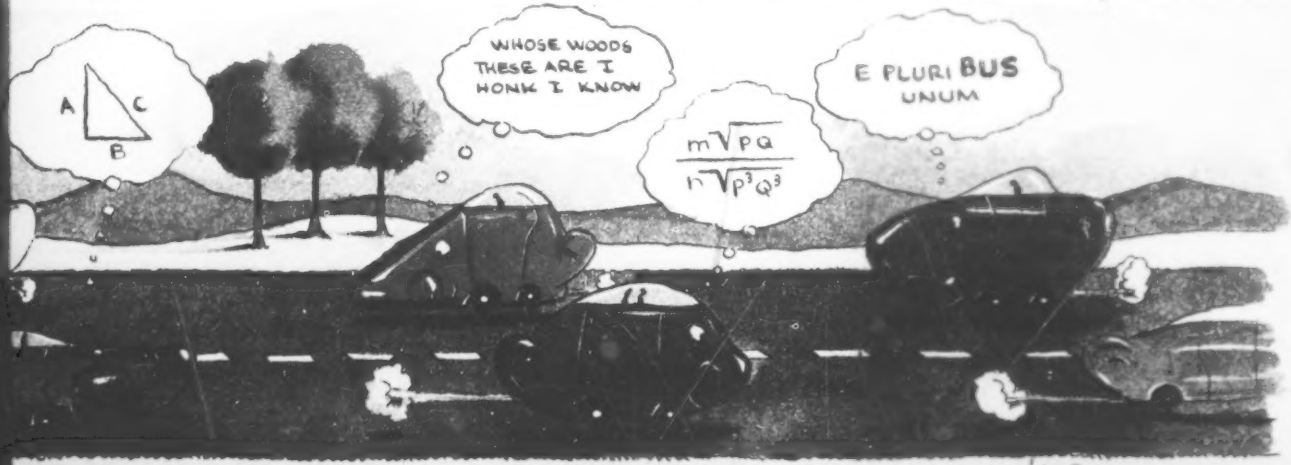
At the same time, large electronics systems makers are getting into the business in a big way by acquiring smaller sensor manufacturers. Allied-Signal Inc., Borg-Warner Corp. and TRW Inc., for example, have either acquired or forged working partnerships with one or more sensor makers to develop and supply sensors for their systems.

But despite the opportunities for sensor makers in new applications and new technologies, supplying the auto market today is a monumental task. All sensor designs for automobiles are custom, and sensor makers have to bear the cost of multiple redesigns, specification changes and whatever else is required to meet the needs of automakers. The first sensor applications were mandated and "you were driven to using what was available," says Ford's Giachino. Today's new applications, however, are refinements to the automobile. Sensor makers must meet carmakers' exacting specifications and no compromises will be accepted.

Some requirements have not changed. Sensors must operate in filthy, humid and sometimes salty environments, with torturous engine compartment temperatures spanning a range of -40 to +120°C. They must withstand constant vibration and shock. And the sensor maker must be able to supply them cheaply and in high volume.

Changing requirements

But some requirements have changed. Quality and reliability goals at U.S. automobile makers have skyrocketed in the past three years. Automakers are striving to produce cars that they can warranty for 10 years or 100,000 miles. "All of a sudden the [quality] norms from yesterday are gone," says Thomas Mabrey, director for marketing for Honeywell's Microswitch Division. U.S. automakers no longer want to take a

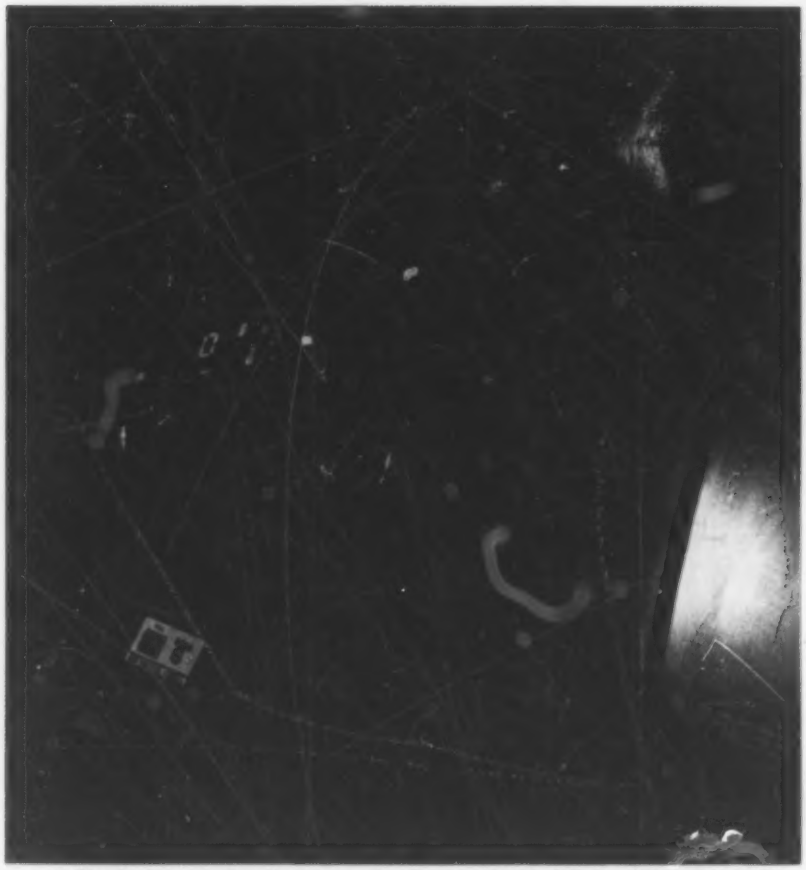


backseat to the Japanese with respect to quality.

Higher accuracy is also a new demand of automakers — particularly for new solid-state sensors used in engine control applications. Automakers want to provide tighter control of the engine, to provide better engine performance, higher fuel efficiency and lower pollution emissions. The reason? Engine performance and fuel efficiency are vital selling features of today's cars, and, experts say, auto companies are worried that the Environmental Protection Agency, which relaxed pollution control standards for the 1988 model year, will tighten them back up again.

But while these new and old requirements pose a considerable burden for sensor makers, perhaps the greatest burden they bear is enduring the arduous design-in process that automakers go through. While the design cycles of U.S. automobiles have actually gotten somewhat shorter than the five-year norm of several years ago, the effort has become more concentrated. Cars are subjected to more development work and testing than ever before. This has a direct impact on sensor vendors. "Everybody's relying on more and more up front development by the supplier," says Giachino.

Honeywell, for example, dedicates a full-time three-member engineering team to each custom project for its duration (typically three to five years). The team, based at Honeywell's Freeport, Ill., headquarters, is at the customer's beck and call. But even this commitment, says Honeywell's Mabrey, "is never enough in the eyes of the auto customer. Responsiveness is the real issue with them. They want to be able to call somebody and know they're going to get an answer when they need it."



Joseph Giachino, supervisor for sensor development at Ford Motor: "There's a million different technologies" used for auto sensors now, making it difficult for any single company to gain a monopoly

Massive development costs

And what do the automakers call about? They call about design changes. During a typical sensor design cycle, Honeywell will make four major design changes, which, says Mabrey, "is just like starting from scratch." In addition, perhaps six or more minor changes will be required, which may involve altering an electrical specification slightly.

Finally, once the design is approved and ready for production, Honeywell has about nine months to ramp up from zero to volumes of several thousand sensors per day. By this time, Honeywell has spent from $300,000 to $1 million on a major design. Although dedicated tooling and equipment is the customer's responsibility, says Mabrey, all other costs are born by the sensor maker. With this resource commitment required, there is plenty of evidence for the belief that supplying auto sensors has become a big company business. Says Ford's Giachino: "Small companies have gotten in in the past, but it will probably be harder to do in the future."

In fact, small sensor firms have allowed themselves to be acquired by larger companies to provide them with the economic wherewithal to sustain the necessary high development costs. Lon Bell, founder of 18-year-old Technar Inc. and now president of this TRW subsidiary, credits their acquisition with providing the resources to spur "triple digit growth" this year, with the same expected for next year.

But the acquisition of sensor makers is part of another trend: the move by automakers to purchase complete systems — such as an airbag system, a dynamic suspension system, or an antilock braking system — from a vendor. Such systems include a sensor as one small but vital part of a complete package of control electronics and system mechanics. Automakers like the idea of buying systems, because it shifts the responsibility for developing, testing and manufacturing major and complex chunks of the car to vendors. "It's a question of where can you put your resources the best," says Giachino. Contracting out allows automakers to become systems integrators and leave the more specialized work to specialists.

Junebug Clark

In 1986, TRW, for example, purchased Technar, which was previously a privately held, 150-employee manufacturer of crash sensors for the rapidly expanding crash bag market. Today, says Bell, 80% of Technar's sales are into complete crash bag systems or subsystems that TRW supplies to automakers.

For founder Bell, becoming acquired was an important strategic move. "It is my perception that it cannot be a long-range strategy to be just a components supplier," he says. The trend toward systems will continue, he explains, and those companies whose size is below a certain "critical mass" will be reduced to supplying the automobile market with components that are commodities, such as a bracket, an O-ring, or some mature, low-technology sensor.

Still, a small company can still make it today as a high-technology sensor supplier. For the small fish in this big pond, the key to survival is having a hot technology — and teaming up with a partner. For IC Sensors Inc., a maker of micro-machined silicon sensors in Milpitas, Calif., the move by the auto industry to buying systems is actually making it easier to supply the automotive market. In fact, IC Sensors' strategy is to sell to the systems houses, not to the automakers directly.

"We need the big buffer in between," explains Donald G. Lynham, president and CEO. The private, under $20 million firm takes advantage of the large systems companies' longstanding relationships with automakers, as well as their sales and marketing resources. "Small companies have a much more difficult time interfacing with the automotive people," says Lynham.

Although supplying the auto market via systems companies relieves the 6-year-old vendor of a considerable marketing burden, it still carries its own set of problems. For one, IC Sensors gives up much of the control and visibility over its market. If its customer, the systems maker, does a poor job of developing or marketing the system, it may never enter production, explains Lynham.

"You have to pick your customers very carefully or you can end up doing a lot of free work," he warns. Lynham looks for his customer's commitment to a particular project. "If he's putting his junior people on the program and saving all his good people for something else, it immediately raises a question mark.

Evolving auto sensor uses

Date of Introduction	Application
1978	Emissions contol
Early 1980s	Airbag trigger system
1984	Dynamic suspension system
1985	Antilock braking, compass
Early 1990s	Electronically controlled automatic transmission
1990s	Navigation control system, including radar and electronic maps

Risky proposition

Lynham tries to negotiate nonexclusive contracts that allow him to sell the sensor to multiple companies, although he acknowledges: "We don't always get our own way." He also negotiates for an up front supply contract guaranteeing that they will supply all or some portion of the production requirements for the application. But supplying system makers is still a risky proposition.

In the engine alone, 15 sensors measure everything from air flow to manifold pressure

Even though marketing is less of a problem in dealing with systems companies, the resources required are still considerable. Lynham estimates that a particular application consumes anywhere from two to six man-years of engineering talent, to get the project from the design stage to preproduction. The total bill often runs $500,000, with the sensor maker absorbing over half the costs.

The reason sensor vendors go through all of this, of course, is for the tremendous volumes that will be their's when (and if) a design reaches production. Revenue, however, is only one of the attractions. The automotive market has a far more strategic role for semiconductor sensor makers, not unlike the role that the dynamic random access memory market plays for traditional chip companies.

The ultra-high volumes of automotive applications act as a "technology driver" that pushes down sensor production costs across the board. "It makes you very competitive in all your other marketplaces," says Lynham. Also, he adds, being a supplier to the automotive industry enhances the vendor's credibility. "It's a very powerful sales tool for any other application you want to go after."

But Lynham is wary about allowing his company to become too dependent on the automotive market. Eventually, he wants to acheive a balance between IC Sensors' medical, industrial and automotive/transport businesses, relying on automotive for no more than one-third of his company's revenue. Today, automotive represents 10% to 15% of the company's business, with the majority split between medical and industrial.

Sensor makers view the automotive market as a building block for their companies, and IC Sensors' Lynham calls the considerable resources that they put into designs "an investment." At Novasensor, president Joe Mallon refers to his company's business strategy as a "two-phase plan." The first phase involves generating revenue by selling product into the medical and industrial sectors, which funds development work for the automotive product. The second phase comes when these automotive designs reach production.

What about the threat of the captive sensor divisions that many systems makers are acquiring? Doesn't this limit the independent sensor makers' market? Lynham says the key is to have advanced technology. If the sensor maker's technology results in the most reliable, low-cost solution for an automobile application, then it will make sense for a systems company to form an alliance with the independent company.

"The smaller companies have the technology," says Lynham, "and the bigger companies have the market opportunities, capital structure and horsepower." □

Wanted: Ways to beat the high cost of test

Firms that must test chips or boards are tired of spending so big to buy and use ATE gear. Here's what they — and the ATE vendors — are doing about it

BY DAVID CARD

Electronics companies have been whining about the high cost of automatic test equipment for years. Beyond the million-dollar price tags on chip and circuit-board testers, the cost of programming the machines often far surpasses the initial equipment price.

Al Key, a test manager at General Electric Co.'s Solid State Division, estimates that in most cases, test accounts for 7% to 10% of the manufacturing cost of a semiconductor device. The percentage of development cost is higher: 20% where CAE simulators produce many of the patterns used in the test program; but up to 70% where programs are extensively hand-tuned.

So now, many users are acting to beat high testing costs — in ways that could have a major impact on the already wobbly ATE business. Some companies are refusing to invest in the big-ticket testers, instead designing their products for easier testability and spreading lower-cost test systems along manufacturing lines. Others are turning to a technique called "scan" technology, which considerably enhances testability of more complex systems. And top management at many ATE users, which has always signed off million-dollar purchase orders, is now becoming involved earlier in test strategy sessions.

Apple's VLSI test manager, James Bray: "The answer long-term is the complete integration with simulation"

Cindy Charles

Anticipating the market shifts ahead, the ATE suppliers are also coming up with cost-beating solutions. Some already offer low-cost models; others are pitching stripped-down models aimed at particular test niches. And most are making their testers easier to program, and tying them closer to computer-aided engineering. But the vendors argue, as do most ATE industry analysts, that is about as much as they can do — quality products demand quality testing, and quality testers don't come cheap.

Users can also make test savings a matter of resource management, according to Joseph Lassiter, vice president of ATE leader Teradyne Inc. He suggests that management must stop rewarding design engineers based on time-to-prototype. Instead, an approach that values time-to-shippable product is needed. That way, testability would receive the attention it deserves, he says.

There are other options, of course: "The classic way to keep test costs down is to get your vendors to test for you," laughs Edwin Ely, director of U.S. systems and hardware engineering at Siemens Information Systems Inc. in Boca Raton, Fla. Realistically, Siemens tries to push testing back as early in the manufacturing process as possible. A project's test director, working with engineering and design personnel, decides how this is done, then Ely reviews the process.

New buyer profile

The users' new buyer profile is evident to Vincent Lutheran, general manager of Tektronix Inc.'s Semiconductor Test operation. He says that when trying to sell his new model, he runs into division managers at least, and usually vice presidents. He often brings along Tek divi-

sion vice president Richard Knight and even president David Friedley. Tektronix may be a $1.4 billion company, but considering all the businesses Tek has recently spun off, Lutheran has to convince potential customers that Tek is in ATE to stay. It is unlikely that ATE leader Teradyne's president Alexander d'Arbeloff has to make similar reassurances.

Tektronix offers examples of the new wave of relatively low-cost test practices. Tek's Vista family of testers is aimed specifically at custom chips, and weighs in at $500,000 to $1.9 million, rather than starting at a million and a half. It's an open secret that Tek is also exploring the latest ATE niche — the so-called design verification systems. Verifiers are another peg lower in cost, and are geared to test prototypes and short runs of custom chips.

Plus, Tek's Knight says his company is looking seriously at the board test market for the first time. Integrated circuits, he says, will always require a big tester at the end of the line, but board testing is different. "Board test has historically grown up around super machines," Knight says, "but the manufacturing environment is changing." Techniques such as just-in-time inventory schemes and manufacturing cells demand "smaller, more flexible machines distributed throughout manufacturing."

Support Technologies Inc., a Tek neighbor in Portland, Ore., makes such a tester. Support originally targeted the service test industry, but now finds half its business in production and manufacturing. "A major price restructuring is going to happen" in the board test business, remarks Support vice president Thomas Bush. Of course, this comes from a company that expects to see $6 million in sales this year. Cynics point out that nothing really happens in a new market until major suppliers come in. No one believed in in-circuit board testers until big guys like GenRad Inc. and Hewlett-Packard Co. started selling them, according to one market researcher.

Exorbitant costs

San Jose-based industry watcher VLSI Research Inc. shows that the average selling price of a high-end component tester topped $1.2 million last year. Ten years ago, an aeon in electronics, testers cost under $400,000. "The reason people spend these exorbitant prices is that these testers are the best way to get the job done," analyst Dan Hutcheson says. "There is not some magical company out there that has figured a way to test cheaply."

The cost of developing these testers is as exorbitant as their price tags. Hutcheson estimates a company has to spend $50 million to $100 million to get into the ATE business. So eight or nine suppliers are spending $1 billion every five years for a market that's worth "maybe half a billion dollars," he says. Making money in such a market is hardly the easiest thing in the world.

The ASP of a high-end component tester topped $1.2 million last year, three times its price 10 years ago

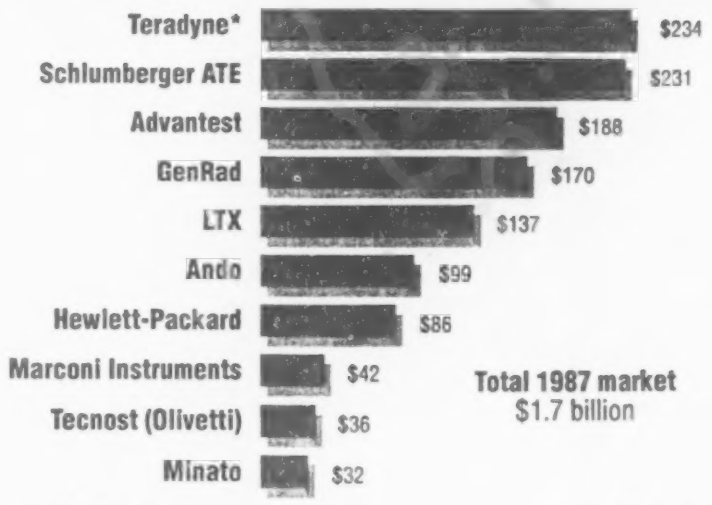
Megatest Corp. president Steve Bisset is almost nostalgic for the days when Fairchild Camera and Instrument (now Schlumberger ATE) dominated the ATE market. Smaller companies picked niches "and we made lots of profit," he says. Now, many semiconductor companies expect to try out ATE for six months — for free. Bisset says that's asking Megatest "to commit suicide." Trillium president James Healy blames that practice on Japanese ATE companies, whose rich parents (Fujitsu Ltd. for Advantest Corp., NEC Corp. for Ando Corp.) can afford it. It is like giving a little kid a puppy, Healy says. "And who's going to give back the puppy dog?"

Trillium did just introduce a $350,000 model indicative of the latest ATE strategy — offering cutdown models for simpler production testing. "I don't think we could go any lower," says LTX Corp. vice president Roger Blethen. Westwood, Massachusetts-based LTX is Trillium's parent.

Semiconductor Test Solutions Inc. pioneered the market Tektronix's testers are entering, because president David Mees saw multimillion-dollar testers and could not "imagine a production line with 10 or 20 of those." STS testers, for instance, coexist with a Megatest model and verifiers from Asix Systems Corp. and Integrated Measurement Systems

Top suppliers of ATE in 1987

Worldwide sales ($ millions)

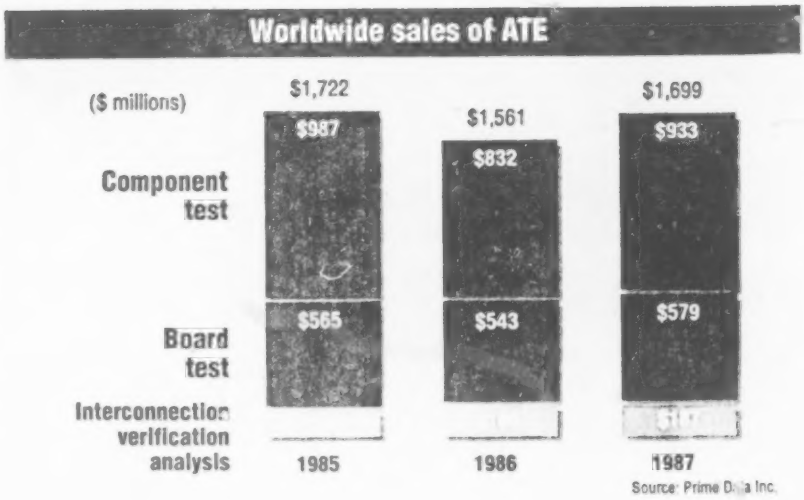


* Includes Zehntel

Source: Prime Data Inc.

Corp. in VLSI Technology Inc.'s production room, labs and design centers, according to VLSI's test manager, Kenneth Von Egmond. Yet Mees, who makes testers priced in the midrange, is feeling enough heat from below to consider reselling —or buying a maker of — verification systems "as a barrier."

It's not as if the verification market is not feeling ripples itself. San Jose market research firm Prime Data Inc. says the business was worth just under $40 million last year and sales growth is slowing down. "It is already crowded at the low end," says Hewlett-Packard marketing exec Matthias Stahl, whose Boeblingen, West Germany, division is introducing a new verifier this month.



Scanning the horizon of test

Still, industry watchers agree that the move to cheaper systems is faster in board test. Board test leader GenRad is well-positioned to take advantage of market shifts — its Phoenix division makes low-end testers that compete with those from Support Technologies. GenRad president Robert Anderson admits that computer companies, which tend to buy his low- and midrange products, are less likely to buy his top-line models. "There's no question that doing a good job of design verification and process qualification reduces the number of testers needed," Anderson explains.

Meanwhile, ATE consumers are still concerned about cost. "Boundary-scan will beat the high cost of test," says Sol Black, senior engineer at AT&T's Circuit Pack Test unit in Columbus, Ohio. Scan technology is a process where paths are designed into circuits giving a "window" into their functions. Extra switches are added to the design to "serialize" the complex logic functions of a circuit, and to make them more easily traceable by test equipment. Scan does impose performance and chip real estate penalties, but Black and others say it is getting to the point where boards and chips will become too complex to test without it.

Black tests boards with a variety of in-circuit testers, but he is not particularly fond of the situation. For one thing, his testers have to attach to the board by probes connected to each component. As less accessible surface-mounted components populate AT&T boards more and more, the connection problem becomes "scary," according to Black. Scan-designed chips on a scan-designed board would allow Black to use "a lot less expensive testers." But few

ATE market outlook: Boom in '88. Bust in '89?

Relatively speaking, 1988 will finish a boom year for ATE. So why aren't suppliers smiling? Robert Anderson, president of board test leader GenRad Inc., says he doesn't want to use the "B" word "because it implies 'bust' follows it. We're being very careful how we ramp up." Anderson says GenRad had its best first quarter in over three years — and that was after getting out of the chip test business. GenRad did, however, have a flat second quarter.

Analyst Kenneth Neff at Prime Data Inc. forecasts a 13% to 15% growth in world ATE sales for 1988. Sales will nudge $2 billion this year, but plod up only 5% in 1989, when Neff is calling for a general economic slowdown. After that, things should bounce back to "middle to high teens" annual percentage growth.

Recession next year? Anderson says: "Can't call it yet. Who knows?

Worldwide ATE sales will nudge $2 billion this year, but plod up by only 5% in 1989

Typically, board test lags chip test. That correlation was a little out of whack from 1985 through 1987, but if it's true, that should translate to steady demands later this year and early next year."

Frederick Bihler, president of Japanese chip tester Advantest Corp.'s U.S. subsidiary, is pretty chipper: "We're generally forecasting an improvement over last year, which was a record year for us." Irwin Pfister, vice president of Schlumberger ATE, is seeing improvement across all product lines for a change. That means board test sales are up, too. Still, it's "not a runaway market."

Edward Rogas, a vice president at Teradyne Inc., agrees that "business across the board — some is very good and some is good." Rogas says he doesn't think that anyone is "massively buying," but memory test sales are booming —at least to manufacturers in South Korea. □

merchant chip makers use scan.

Logical Solutions Technology Inc. of Campbell, Calif., is trying to change that. President Jon Turino is pushing a scan-oriented "testability bus" design through IEEE standards committees later this year. Logical Solutions will gladly sell you a chip set incorporating the bus, or license the technology to merchant semiconductor houses. A 50-cent testability chip will allow boards to be tested by $150,000 testers instead of $1.5 million ones, Turino claims.

Apollo Computer Inc. used a scan-oriented simulator from Teradyne's Aida division as well as others to help design the RISC processor at the heart of its latest workstation. Apollo management had to buy into the theory of design for testability early on, says marketing manager Paul Bemis. For one thing, Apollo had to do some serious simulation — 25 of its high-end workstations, 17 with Aida accelerator boards, were dedicated to simulation. Apollo spent a whole year doing timing verification after the initial design was done. And it gambled on a small company for its chip, Integrated CMOS Systems Inc., partly because of its scan expertise.

Sunnyvale-based ICS tests Apollo's chips with a special scan tester from start-up Gillytron Inc. of San Jose. Gillytron's ultra low-cost, personal computer-based tester can test the ICS chips more thoroughly than conventional ATE, claims ICS vice president Tom Miller.

Here are a few other examples of users' strategies for beating the high cost of test:

AMD: Pay up front

Advanced Micro Devices Inc. vice president Gary Ashcraft admits that his strategy to trim test costs — buying big, costly testers early — appears contrary. "It probably isn't obvious from casual observation," says the head of AMD's Austin, Texas, Communication Products Division, "because they *are* very expensive testers." He's talking about his top-of-the-line, million-dollar, mixed-signal A500 tester from Teradyne.

But Ashcraft says the ploy saves in the long term. The A500 allows him to test the analog and digital functions of AMD chips simultaneously. With test times measured in seconds, loading a chip into two separate testers costs money in terms of "throughput." The A500 is easier to program, he says, so that even with the mixed-signal capability, a single engineer can handle a given component. Ashcraft is seeing up to 50% productivity gains in his programmers. Productivity is key, he says: "Even if the testing costs the same, it's worth it in terms of time-to-market."

Apple: Software salvation

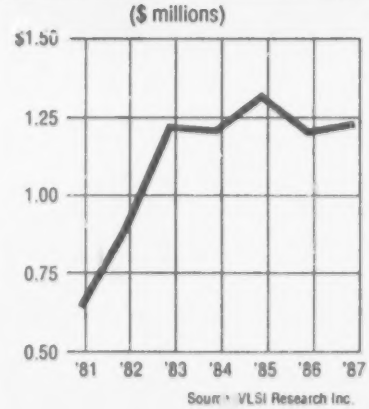
How to beat the high cost of test? "The answer long-term is the complete integration with simulation — where the tester software *is* the simulator software," responds Apple Computer Inc.'s VLSI test manager, James Bray. He wants to eliminate test programming completely.

Apple simulates ASICs with Mentor Graphics software, but Bray is also investigating "next generation" tools from Gateway Design Automation Corp. as well as HHB System's automatic test program generator. Apple's simulation mandated a per-pin tester for easy programming, and Bray is evaluating machines from LTX/Trillium, Megatest and Teradyne.

Apple's automated Fremont, Calif., plant is geared to just-in-time manufacturing. So Bray actually doesn't do much incoming inspection: "We want to push that back on the vendor." He won't force an ASIC house to use the same kind of tester he uses, but doing so is the only way to use Apple's design data efficiently.

Two separate project teams at Apple are evaluating various scan techniques. Bray says Apple is so sold on scan that if chip vendors don't adopt it, Apple might put in its own. For instance, rather than buying standard 68030 microprocessors from Motorola Inc., Bray speculates, Apple might license the 030 technology, and build up scan and other functions around it in a custom chip.

Average selling price of a VLSI chip tester



Barring price-pressure dips during two economic downturns, tester price tags are headed unerringly north

Honeywell Military Avionics: Small is beautiful

They test testers at Honeywell Inc.'s Military Avionics Division, and they like to use small, low-end equipment to do it. Production engineering supervisor Jon Thom's group builds and tests some of the boards that go into the Air Force's MATE military tester.

A Honeywell team was looking at functional testers — the million-dollar kind from GenRad and Teradyne — but realized that the benefits from those were largely simulator-driven. Since the MATE design team didn't use simulation, Thom reasoned, he didn't want to spend that much.

So Honeywell opted for a low-end functional tester from Support Technologies that plugs into the MATE system's controlling microprocessor. Honeywell also practices distributed testing: before a MATE board reaches functional test, an in-circuit tester from GenRad catches manufacturing defects.

Honeywell design engineers don't simulate the MATE boards, but they do write diagnostic procedures — the Air Force requires it. Those procedures translated to the Support tester, Thom says. To ensure design/test cooperation, Honeywell "transferred some design folks into production." The strategy was easy to sell to management because it "saved a lot of dollars and a lot of the schedule." □

PCB firms spending more in face of coming shakeout

As quality becomes customers' No. 1 priority, board makers are investing heavily in automation and optical test equipment

BY TONY GREENE

Quality is the name of the game in printed circuit boards these days. When industry executives are asked what their biggest challenge — and No. 1 priority — is, the answer is unanimous: quality. Customers are getting tough. Where once fail rates were measured in parts per hundred or thousand, customers now are demanding PCB manufacturers deliver goods that have a fail rate of parts per million.

Meanwhile, as PCBs get more sophisticated, it gets harder to meet customers' demands for vastly improved quality. Today, buyers want finer lines, more layers and new technologies, such as surface mount. The increasing prevalence of just-in-time manufacturing, which mandates the delivery of near-perfect goods to the OEM just in time for use, also is driving the push for quality. To meet all these demands and still provide better products, companies must invest heavily in new equipment.

Indeed, quality costs money — and lots of it. To satisfy demanding customers' requirements, PCB manufacturers must invest in advanced technology, including costly electrical and automated optical (AOI) inspection.

Unfortunately for PCB makers, the investment funds must be raised in an industry that most analysts agree has one of the lowest average profit margins, around 10%, in electronics. From now on, it's survival of the fittest. And the survivors will be those with money to spend. So, while quality may be the buzzword on everyone's lips, money for capital expenditures — and where it will come from —is the problem on everyone's mind.

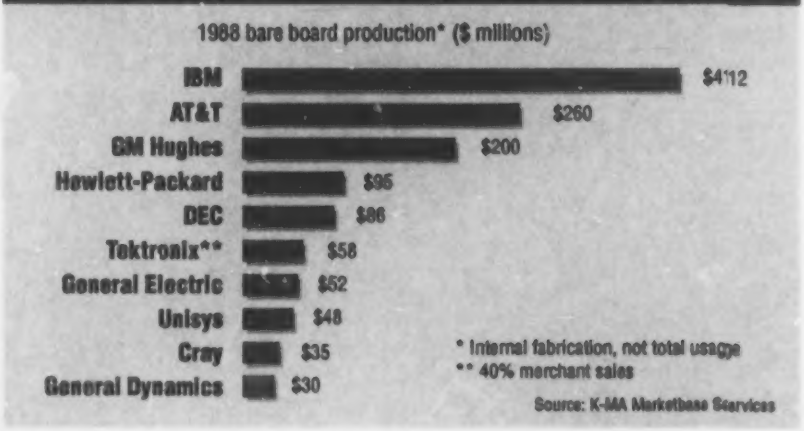
Most PCB analysts agree that there will be a shakeout, consolidating the industry at the top end. The big shops, with more than $50 million in sales a year, will get bigger. And the medium-sized shops — $10 million to $50 million annually — will get squeezed out. With less need for expensive automation equipment for prototype work, the number of small shops, with annual revenue of $10 million or less, should remain relatively constant. Still, things could get tough as the large shops become proficient at quick turns on small orders. The PCB industry in the United States is estimated at $5.4 billion for 1988, with a growth rate of 16.9% for the year, says Philip Lapin, president of Electronic Marketing Consulting, Redwood City, Calif.

While capital investment strategies vary, PCB makers actually have several things in common. They are:

- Buying equipment that will increase production yields and speeds. Big board makers are leaving the cutting edge technology to small shops, concentrating instead on automation.
- Diversifying product lines and customer bases to avoid depending too much on any one customer, as many did before the 1985-86 slump.
- Concentrating expenditures on equipment that will insure good-quality high yields. As production output has risen, it has become imperative that flaws are caught quickly and corrected immediately. "Automated optical inspection is near the top of the list," says Harvey S. Miller, president of K-MA Marketbase Service, a Palo Alto, California-based research firm.
- Borrowing little and financing capital investments internally. Many PCB makers are still saddled with debt incurred before the slump and they don't want to get caught short again.

"We try to put 10% of revenues toward capital expenditures," says John Kropper, president of Hadco Corp., Salem, N.H. "And we try to finance our capital investment out of earnings." Kropper says that Hadco has already spent $8 million in the first six months of 1988 and that he expects to spend another $8 million in the second half. ▷

Top U.S. captive makers of printed circuit boards



Hadco led the industry last year with sales of $115 million and expects to lead the industry again this year with sales of $140 million, a 22% increase. Hadco's investment strategy also includes a plan in which sales and marketing employees specify the kind of products that they believe customers will want over that period, and recommend the kind of investments that will be needed to fulfill that demand. The manufacturing team then comes back with plans to satisfy those requests.

John Carr, president of Continental Circuits Corp., a Phoenix, Arizona-based PCB manufacturer, agrees. "The key to our capital investment strategy is to plow revenues right back into the business," he says. Continental Circuits generates about $1 million in cash every month, according to Carr, with profit margins averaging 11.5% of sales. The firm predicts sales will climb 25% this year to $75 million, from $60 million in 1987. Carr, meanwhile, expects to spend $10 million this year and $20 million more in the next two years on capital equipment. Continental tried to raise some of that money through an initial public offering in October of 1987, but got caught in the stock market crash and had to abort the plan. Continental also subsidizes its purchases by selling the equipment that is about to be replaced. The company has a full-time employee who does nothing but find buyers for the used machinery.

Fifth-ranked Advance Circuits Inc. of Minnetonka, Minn., has a different strategy. "We try to limit our capital investment so that the amount that we spend is equal to our depreciation," notes Thomas Leahy, Advance Circuits chief executive. "We want to pay our debts with depreciation." In 1980 and 1984, Advance Circuits defrayed costs by raising funds through stock offerings — an advantage, Leahy says, that public companies have over private firms. Advance Circuits has invested $15 million in equipment in the past three years.

Top U.S. independent makers of printed circuit boards

Source: K-MA Marketbase Services

Independents gain ground

These strategies seem to be working. Independent PCB makers are increasing their share of the total market. In 1987, independents captured 60% of the market, with captives accounting for the remaining 40%, according to the Institute of Interconnecting and Packaging Electronic Circuits (IPC), in Lincolnwood, Ill. For the independents, that's a 9% increase from the previous year.

The big captive operations still dwarf the largest of the independents, However. IBM, the U.S. leader in PCB manufacturing, is forecast to build $412 million worth of boards in 1988, while AT&T and GM Hughes Electronics Corp. are expected to do $260 million and $200 million, respectively. One reason these shops are going outside with board business is that independent board shops are performing better than ever.

The big PCB firms will get bigger and the medium shops will get squeezed out

"Captive operations are using the independent manufacturers as a buffer for their business operations," according to Gene Hendrikson, general manager of Tektronix's PCB facility. "We would rather handle the increase in the independent market than spend the money on the equipment ourselves." Tektronix has made a move toward the independent market, doing 40% of its projected 1988 sales of $58 million in the merchant board market. According to Hendrikson, Tektronix is performing well enough in the independent market to fund its own operation. "We have reached the point where we can compare with the best independents in the business on cost and quality," he says.

"Printed circuit boards are the kind of product that work best in an independent environment with an entrepreneurial approach," says K-MA Marketbase's Miller. Because of this flexibility, independent board makers can produce higher quality products for less than captive shops. Jack Mettler, president of North Haven, Connecticut-based Circuit Wise Inc., notes that the IPC figures also reflect increased demand for printed circuit boards this year and last. There are other factors driving OEMs with captive shops to the independents. "The market as a whole is going to independents because of specialization," says Continental Circuits' Carr. "Historically, large companies go outside to fill increased demand during upturns," observes Mettler.

As the industry consolidates, customer service is becoming increasingly important. "There is more and more inclination for the customer to go with one supplier," says Ray Pritchard, IPC's executive director. Miller agrees: "The trend is toward maybe five vendors instead of 200." The No. 1 reason for this is the demand for quality.

As boards become denser and more complex, customers are looking for manufacturers that can provide consistent product and deliver it on time. These same factors are responsible for the fact that PCBs are not im-

ported or exported in great numbers. Multilayer, for example, "is such a complicated product that you need to have the manufacturer and the customer on the same continent," says Miller.

Independent board makers are developing strategies to be more responsive to customers. "One of the ways we are servicing our customers is by having resident engineers that work for us live in the customer's factory," says Keith Robbins, vice president of fourth-ranked Photocircuits Corp., Glen Cove, N.Y. "That way, the minute the guys at the factory know about a problem, our guy there knows about it. And he can call us and tell us how to get it fixed."

Customer service

Hadco, meanwhile, practices what it calls multiple tier selling. "We talk to the executives, the engineers and the support staffs to find out what everybody needs," says Andrew E. Lietz, sales vice president. "We want to support leadership and innovation and form partnerships with long-term technical visions."

Customer service is only going to become more difficult, and the need for capital expenditure is going to rise as the technology involved in the manufacturing of PCBs becomes more and more complex. One of the major forces in this push is surface mount technology. SMT is driving the size of linewidths down, and is causing the density of the boards to increase dramatically as chips are being mounted on both sides of multilayer boards.

"The increasing density of boards is running the prices up faster then customers want to pay," says Prudential Bache analyst Edward B. Keaney. Pritchard at IPC says, "It is difficult for companies to charge a reasonable amount for their product." In addition, increasing use of JIT in manufacturing is pushing up demand for perfect production runs at low prices. "Anybody who is not looking at just-in-time is not going to be in the business in the next five years," according to Pritchard.

Printed circuit board makers also are working hard to diversify and expand their customer bases. None of the manufacturers want to be so closely ties to one customer that their fates are inextricably intertwined. "No one customer is allowed to represent more then 15% of our business," says Hadco's Kropper.

In line with this is a push by the large manufacturers to diversify product lines and not become tied to one group of OEMs. Finally, the doctrine that is sweeping the industry is high tech at high volume. It is not as important to be on the cutting edge as it is to produce the high-tech boards — and a lot of them. As a result, the big board shops are happy to leave the small specialized orders to the prototype shops. ▷

Orange peel to the rescue

Scientists have been saying for years that the ozone layer, a critical portion of the earth's upper atmosphere, is disappearing at an alarming rate. All this concern is because the ozone filters out ultraviolet radiation from the sun before it reaches the earth, allowing us to enjoy the sun without undue fear of skin cancer and other complications that unfiltered sunlight can cause. But the ozone is under chemical attack from chlorinated fluorocarbons, which are used in spray cans — and in circuit board manufacturing.

Orange peels may save the day. AT&T and Petroferm Inc., a small chemical company, have together developed a compound they say will replace Chlorofluorocarbon-113 (CFC-113) as a solvent in the electronics industry. The compound, Bioact EC-7, is a natural solvent derived from orange and other citrus rinds, as well as wood products. The Enviromental Protection Agency estimates that 10% of the ozone-depleting compounds could be eradicated by using Bioact EC-7 instead of chlorofluorocarbons and other chlorinated solvents.

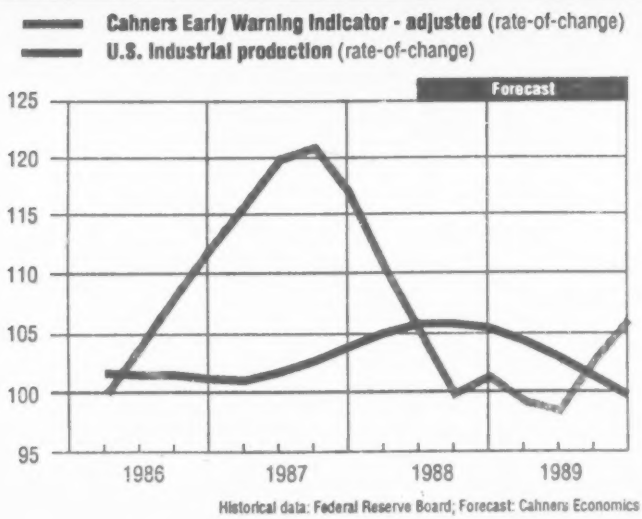
Petroferm's Michael Hayes: It's so safe that in some cases it's called an indirect food additive

"The compound is so safe that it is on the government's Generally Regarded As Safe (GRAS) list and in some instances is even listed as an indirect food additive," according to Dr. Michael Hayes, the compound's inventor. Bioact EC-7 is based on terpene hydrocarbons, which are compounds that occur naturally in almost all organic substances such as: citrus fruit rinds, vegetables, spices, meats and wood products. Terpenes are already being used in household solvents like Pine-Sol and Lysol.

"In addition to being environmentally safer than CFC-113, Bioact can outperform it," says Hayes, referring to a test he has conducted comparing the two compounds' abilities to remove flux, or residue, from printed circuit boards. However, one problem with Bioact is that it must be used only on products that can be immersed in water and in cleaning systems that can accomodate a water wash. Hayes says that Vitronics Corp., a PCB equipment manufacturer, is developing equipment to take full advantage of the compound.

According to John Fisher, supervisor of the solder process technology group at AT&T's Engineering Research Center in Princeton, N.J., "Another benefit of Bioact is that you need less of it. It has a high boiling point and a high loading capacity. It can dissolve a lot of resin and still clean efficiently. The people who are using it are very happy with it." □

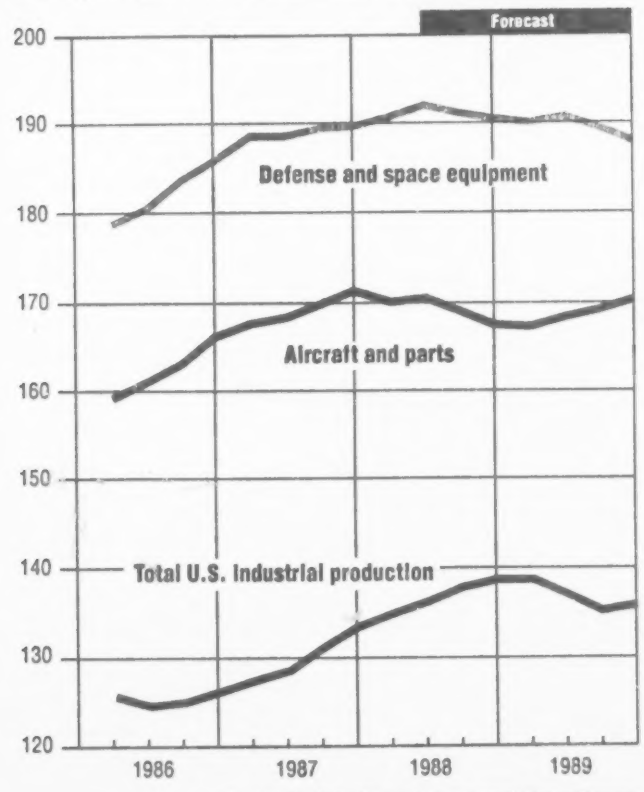
U.S. economic indicators



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Defense equipment — Industrial production

Quarterly averages, 1977 = 100, seasonally adjusted



Historical data: Federal Reserve Board; Forecast: Cahners Economics

U.S. production growth remains steady

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Electronics on top in defense market

Something happened this past April and May that hasn't happened since July of 1978. U.S. factory output of defense and space production fell below year-ago production levels. This decline is indicative of the future state of the defense industry. Cuts, delays and stretch-outs are the depressing future vocabulary of the industry.

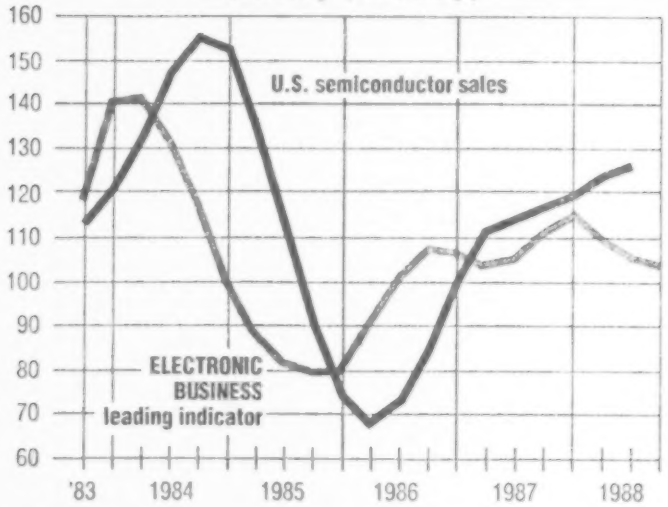
Although the defense budget will be cut (regardless of who's in office), the defense electronics industry cuts won't be as deep. The pressure to modernize, even though awards for new high-tech systems will be rare, will mean existing systems will be upgraded with new electronic equipment.

According to estimates by the Electronic Industries Association, the total Department of Defense budget will decline 3.2% per year on average over the next 10 years. Meanwhile, the electronics portion of that budget will see a 2.6% average annual increase over the same period.

In fiscal year 1987, about 18% of all defense contracts greater than $25,000 were spent on electronics and communication equipment. Another 22% were awarded for aircraft and related equipment and 16% for missiles and space equipment. Over the next decade, electronics' slice of the shrinking defense pie is bound to get bigger.

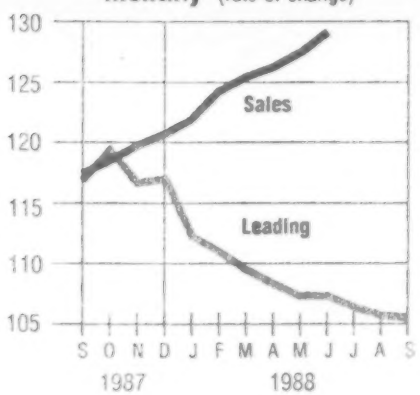
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator saw a decline for the fifth consecutive month in May and is expected to continue declining over the next few months. A drop in stock prices and semiconductor bookings contributed most to the early 1988 slowdown.

Source: Cahners Economics

Electronics industry indicators this month

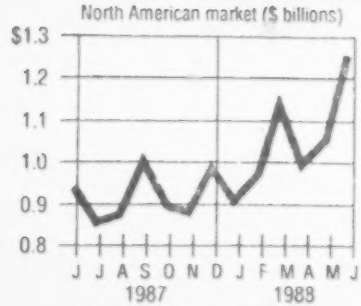
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, May)	108.3	109.5	107.4	111.8
U.S. semiconductor bookings ($ millions, 3-month average, June)	$1,269	$1,223	$981	$951
Weekly hours of semiconductor production workers (monthly average, May)	40.1	40.1	40.6	40.6
Electronic components leadtime index (1977 = 100, July)	123.2	120.2	120.5	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, June)	64.6	58.2	68.0	65.5
Change in electronic components inventories ($ millions, SA, May)	-$50	+$25	-$809	+$47
Contract and orders for plant and equipment ($ billions, SA, May)	$35.8	$37.6	$34.6	$34.5

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

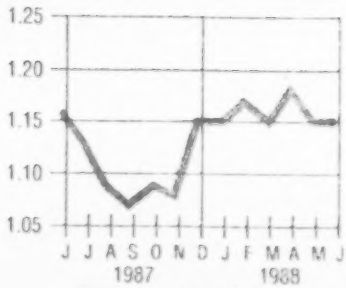
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

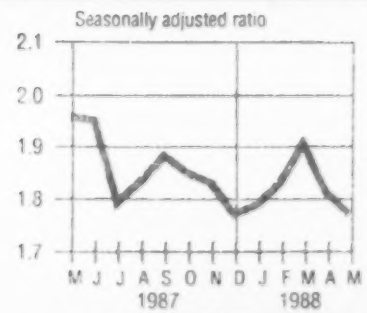
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE SEPTEMBER 15, 1988

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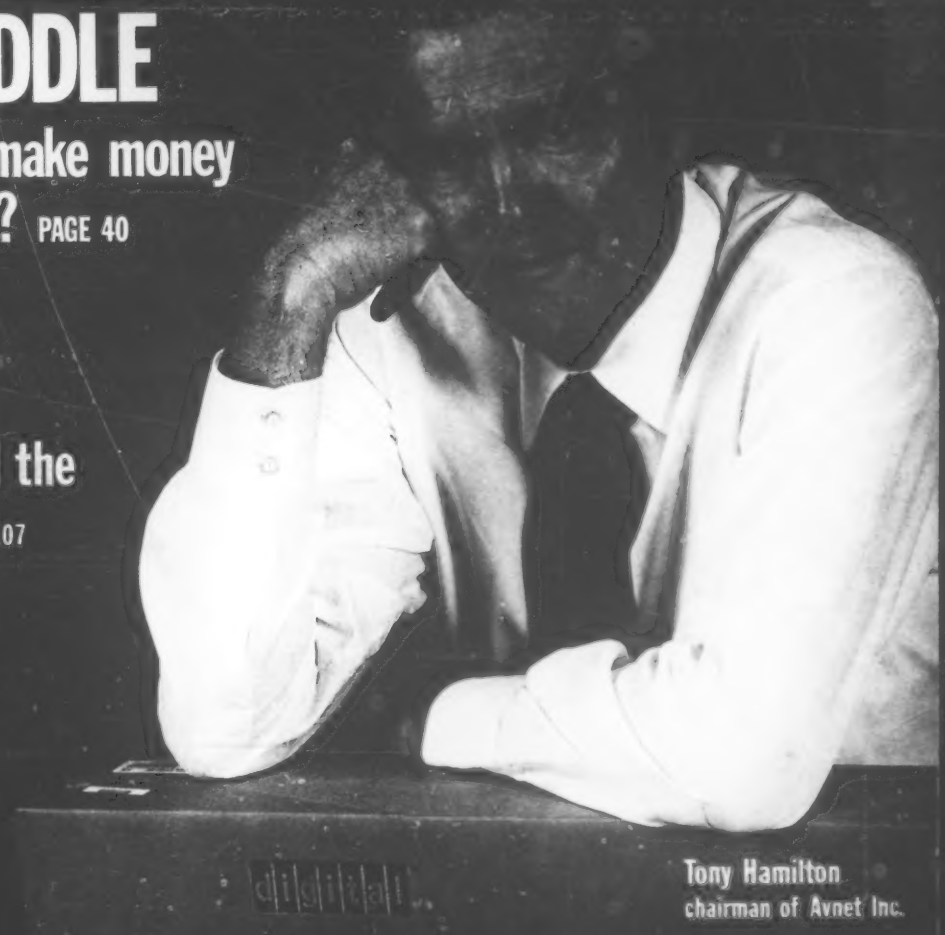

Tony Hamilton
chairman of Avnet Inc.

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 18 SEPTEMBER 15, 1988

PAGE 40 Can Avnet's Tony Hamilton make 25%-plus on computer sales?

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DISTRIBUTION

40 Why distributors may be wrong to sell computers

The push into the computer business by distributors such as Hamilton/Avnet has far-reaching consequences for all companies associated with computer products. For computer and software vendors, it means the possibility of reaching new markets; for VARs and VADs it means being forced to develop new relationships; and for the end user it means another option in purchasing. Sales growth may not be in question, but profitability and channel conflict are.

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Dilemma for distributors

Let's have some sympathy — just a little — for industrial distributors. They're traditionally components kinds of guys, but they just don't seem to get it quite right when it comes to semiconductors. Ordering too much too early, they risk being stuck with shelves creaking with inventory. Too little and too late, and they lose market share by missing the best of the new sales cycle.

To try to escape the feeling that they're just popcorn in the chip-business popper, many of them are opting for what they think is less spicy, but just as nourishing fare: selling computers and computer products. But as our associate editor Bruce Rayner found out, that's no sure stomach-settler because Wall Street has begun asking: "Where's the beef in computer profits?" Tony Hamilton can argue that 20%-plus gross margins are attainable, but the financial types aren't convinced. Tony may have an even harder time supporting his decision to get into the value-added software business too.

There's more on the world of distribution, penned by the able hand of contributing editor Dwight Davis. Dwight found that electronics-industry distributors have been on a sales role lately, expecting revenue to climb 20% this year to give aggregate approaching $8.5 billion.

Associate editor Bruce Rayner

Europe 1992

U.S. electronics firms need to know how to deal with the proposed "United States of Europe," the single economic market idea that may in the end turn out to be little more than a pretty theory. And they need to know now if they're to have any chance of laying out marketing or manufacturing strategies there. Contributing editor Jack Gee explores some of the broader implications in the first of many articles we will run on this crucial topic.

SMT surprise

Makers of circuit-board CAD systems thought they had SMT all sewn up. But they didn't anticipate all the problems SMT would create, such as hot spots on boards. Read the story by our new assistant editor Tony Greene to learn how the CAD lads are coping.

JOHN KERR, managing editor

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BPA ABP

1992: Supplying electronics to 320 million Europeans

Europe is unifying its market. Some say that's great. Some say it ain't. Some even say it'll make no difference. But why is IBM so pleased?

In a recent government-sponsored commercial on French television, a frail-looking yuppie jumps up from his office desk and strips into boxing shorts. Then, he lunges at a formidable Japanese Sumo wrestler and a muscular American baseball player. It's an uneven match. But 11 other young men in shorts bearing the colors of the European Community (EC) come to the rescue. Together, the European dozen beat up the two outsiders.

That TV message is clear. And it deserves attention from American electronics companies. In 1992, the EC's hodgepodge of 12 national markets will merge into a single unit with 320 million consumers. The objective is to create a single marketplace in which physical, fiscal and technical barriers to trade will be dismantled. European countries will no longer be able to put up with protectionist barricades against products from their neighbors. But will this new Europe be an easier or tougher place for U.S., Japanese and other foreign competitors to do business?

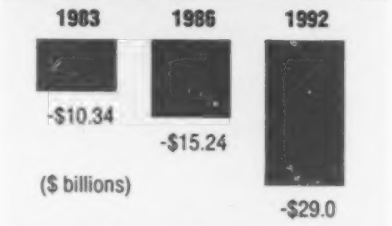
The jury is likely to remain out for some while. The optimists forecast that bigger, more powerful European companies will emerge in electronics and other industries. They say that U.S. and Japanese companies should also find it simpler and cheaper to manufacture and sell in Europe.

Robert R. Heikes, who has successively headed the European semiconductor operations of Motorola Inc. and National Semiconductor Corp., argues: "The U.S. firms can only do even better than now. They have been penetrating each European company with manufacturing, sales and marketing for 20 years. They are ready to attack Europe globally. The Europeans, long confined within their own national frontiers and markets, are not ready for this new challenge."

However, among Europe's industrialists and politicians, there is a strong drive to close ranks against competition from overseas. Robert Taylor, a consultant at European Research Associates in Brussels, Belgium, says: "The question is whether the EC will become Fortress Europe. Americans and Japanese have grounds to fear that Europe will become more difficult to penetrate. There are already signs that the protective barriers which European countries are about to dismantle between each other will be raised again as an EC barrier against outsiders."

Many European business leaders make no bones about their determination to make life more difficult for U.S. and Japanese electronics firms. Bernard Esambert, a banker who served at the top management level with France's flagship computer maker Groupe Bull, says: "We have to create a spirit of industrial nationalism in Europe." Esambert, now chairman of Paris-based Compagnie Financiere Edmond de Rothschild, adds: "Unless we introduce and apply a 'Buy European Act' we shall be a continent that is up for grabs."

Europe's worsening trade deficit in electronics



Europe includes non-EC countries such as Switzerland, Austria, Norway and Finland

Sources: Organization of Economic Cooperation and Development; private forecasters

Europe badly needs a stronger high-tech base. But will a united market provide it?

Norbert Bininda, a Siemens AG telecom executive, argues: "What Europe expects from the U.S. and Japan is more open public procurement practices. It would be very bad if Europe were alone in adopting free-trade measures." However, less than 10% of procurement by Europe's government agencies is put out to international competition. Telecommunications contracts are a traditional preserve for local industry — and likely to remain so.

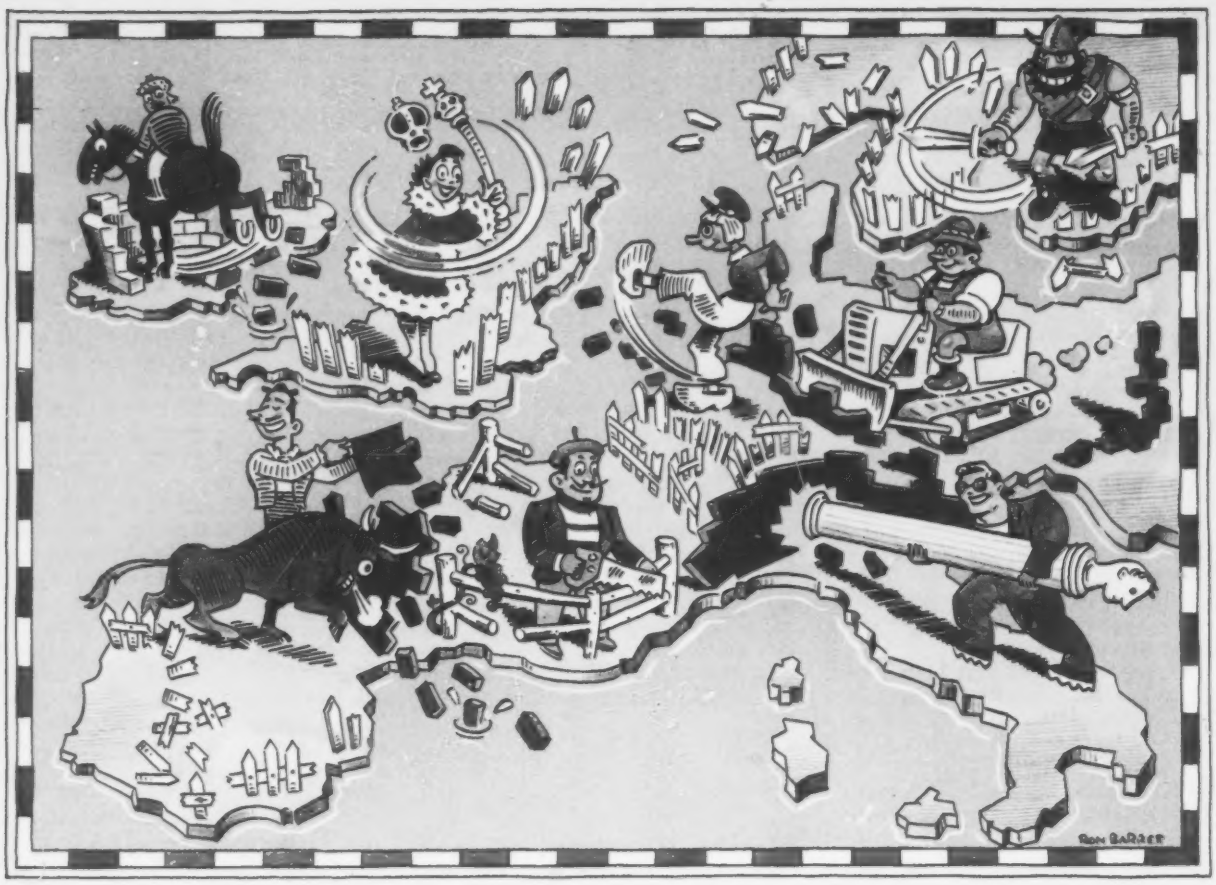
Depressing dependency

The French, whose electronics industry is still depressingly dependent on state funding, are particularly wary of laying down the EC welcome mat to all comers. "Not all the advantages that Europe is granting to its members will be made automatically available to other countries," warns Regis Astier, a senior official of the French Employers Association. "If Europe can't get at the U.S. public procurement market, they won't get at ours."

Henri Froment-Meurice, France's former ambassador to West Germany, says in a report prepared for his government on the outlook for 1992: "In telecommunications, the opening up of the European market is likely to benefit U.S. companies. We need negotiations to ensure reciprocity with the U.S. and Japan."

This suspicion of the United States and Japan reflects European concern about the immense amount of ground its electronics firms have to make up. Last year, the EC reckoned that its member countries were running a high-tech trade deficit of $10 billion. That compared with a surplus of $1.3 billion for the United States and $8.6 billion for Japan.

The Paris-based Organization of Economic Cooperation and Development (OECD) says that, including non-EC countries such as Switzerland, Austria, Norway and Finland,



Ron Barrett

Europe's electronics deficit rose from $10.34 billion in 1983 to $15.24 billion in 1986 and grew again last year. It is likely to reach a whopping $29 billion by 1992, according to private forecasters.

Concern in Europe about how it will perform if trade barriers with the outside world are pulled down is reflected by other grim statistics. Last year, local companies captured only 20% of their continental market for computers, peripherals and software. That is a smaller share than IBM's own chunk of the European market.

In semiconductors, European manufacturers carved out a 42% slice of the local market, but lost ground to their U.S. and Japanese rivals in other parts of the world, according to Dataquest Ltd., the London-based European arm of the San Jose market research firm.

It seems doubtful that the European manufacturers will be able to maintain even their current market shares in semiconductors. Their ability to create a genuine common market in this sector is being severely tested by wrangling between N.V. Philips GL, Plessey Company Plc, SGS-Thomson and Siemens, over an ambitious scheme to develop technologies for the microchips of the late 1990s.

Provisionally named Joint European Semiconductor Silicon (JESSI), the project can expect government and industrial funds of more than $2 billion, more than the $1.5 billion Sematech research venture by leading U.S. chip makers. If JESSI goes ahead, it would match efforts in Japan, where 10 times more scientists and engineers than in Europe are working on advanced semiconductor research.

It's doubtful that European firms will even maintain current market shares in chips

However, the European semiconductor companies are advancing in disarray. West Germany's Siemens and the Netherlands' Philips, which with their governments have provided the initial push for the project, say they do not want Britain's Plessey as a partner because it lacks international stature in the chip business. They are also reluctant to give SGS-Thomson more than a junior role. Hermann Franz, director of Siemen's semiconductor operations, says: "Philips and Siemens will develop the technology itself. SGS-Thomson could be associated with work on design and equipment." Philippe Geyres, director for strategic planning at SGS-Thomson, replies: "Such limited involvement is unacceptable to us."

In readiness for 1992, Europe's computer systems manufacturers are working together to develop joint standards. "These will help the semiconductor industry – U.S. and Japanese firms as well as the Europeans," says Bipin Parmar, a senior industry analyst at Dataquest, London. "Until now, personal computers have had to meet different safety regulations in each country. With unified standards, semiconductor firms can look forward to new prosperity because the 1992 landmark is going to mean bigger volumes."

Parmar does not expect Europe to adopt protectionist policies to exclude imported chips. He says: "This would damage Europe's computer business. Anyway, the U.S. already has well established plants in Europe and now the Japanese are moving in, too." The Dataquest analyst also predicts new mergers between European semiconductor firms, following those between France's Thomson Semicon-

ductor and Italy's SGS and Plessey's acquisition of Ferranti Plc's chip business in Britain. "Critical mass will become more and more vital," Parmar says.

In telecommunications, U.S. and Japanese manufacturers are preparing for the 1992 landmark by trying to beef up their European presence. Northern Telecom Inc. recently began investing $100 million in the development and manufacturing of private branch exchanges at a site near Verdun, France's World War I battle field. AT&T, disappointed by poor sales of its central office switches by Philips, is trying to spice up its business by allying with other European telecom firms.

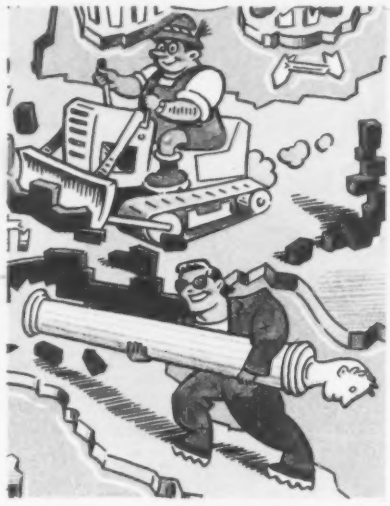
Signs are absent that Britain, the only European country to deregulate its carrier services, will be followed by its neighbors. But there is a trend to ease controls on sales of telephones, computer modems and other communications gear. Until now, these have been under the control of government-managed carriers and telecom authorities. With electronic mail, the fast-growing markets for office phone equipment are worth $8.5 million a year in Europe. However, the timid moves toward liberalization will leave untouched the rest of the $90 million a year telecom European market, including the $60 million basic phone service, a sacred cash cow for governments. In West Germany, the state-owned Bundespost's monopoly over most communication services is contributing $2.7 billion to the national treasury.

Ted Richardson, director of Dataquest's European Telecommunications Industry Service, says: "American and Japanese telecom firms will find themselves under increasing pressure to manufacture in Europe. There's a real danger that, if they don't, they will find that, as the internal European barriers come down, the external ones will be raised higher. EC has made telecom a strategic industry for Europe that it intends to defend."

U.S. companies which are selling but not yet marketing in Europe are looking at the implications of 1992. At CalComp, a manufacturer of computer graphics products which is based in Anaheim, Calif., president William P. Conlin says: "By that date we could be close to capacity in our U.S. plants. That could be the time to turn to manufacturing overseas, particularly in Europe. We are already having difficulties shipping product across the Atlantic. A European plant could be the solution to a number of problems."

IBM relishes 1992

IBM is looking forward to 1992. "We see that date as an opportunity for strengthening Europe's competitiveness," says C. Michael Armstrong, chief executive of IBM-Europe, which is based in Paris. IBM has founded its manufacturing strategy on making a different product at each of its 15 European plants. Personal computers turned out at Greenock, Scotland, mainframes from Montpellier, France, and megabit memory chips made at Sindelfingen, Germany, are shipped to customers around the continent. Big Blue can look forward to saving money when the barriers at Europe's national borders are demolished, sales taxes harmonized and technical standards unified.



Many European companies are clearly worried about the implications of increased competition from their neighbors and from the United States and Japan. "That's sheer weakness of will," comments Alain Minc, head of Cerus, the French holding company of Italian industrialist Carlo de Benedetti, whose empire includes computer maker Olivetti Corp. The payroll of Europe's leading cross-border merger artist now includes as many foreigners as Italians. The newcomers do not have to learn the language because top-level meetings are now conducted in English.

Andre Delage, a director general at Compagnie Generale d'Electricite, the French company which last year merged the telecommunications business of ITT into Alcatel NV, says: "The existing trade barriers are important. But we have stressed them too much as grounds for doing nothing."

Philips is already overhauling a European marketing and manufacturing organization which, until now, has been closely geared to serving its local subsidiaries. These have traditionally made and sold product for the countries in which they are based. But, in rationalizing its operations in Europe, the Dutch multinational is being careful not to upset its customers. For example, Andre Mercier, chairman of La Radiotechnique, Philips' French offshoot, says: "We have carefully cultivated our image as a French company. This is vital for doing business, particularly when bidding for government contracts."

Siemens admits that the challenge of the new European market is posing major problems. "Government attitudes and institutional structures won't change," says Herbert Stich, executive director for sales and marketing at the West German electronics giant. "We will still be thinking in terms of working on the Spanish or Italian markets, not a single European market."

For Xavier de Montfalcon, planning director of Merlin-Gerin, a French maker of electronics and electrical equipment, the priority for suppliers is to understand the ingrained habits of customers in each EC country. "Habits are something you cannot pass laws about," he says.

Europe lags behind the United States and Japan in almost the entire range of electronics products. By 1995, computing and communications are likely to represent 12% of the Old Continent's economic activity, compared with 4% today.

Europe, therefore, faces a decisive choice. One option is to develop a high-tech industrial base which can rival those of the Untied States and Japan. The other, which it would prefer to avoid as much as its rivals, is a dangerous trade war with Washington and Tokyo.

JACK GEE

Smart manufacturers still betting on smart power

It will be a few years before smart power IC sales pass $1 billion. But business is now taking off

Two years ago, the silicon marriage of logic control and power switching — known as smart power — looked like the second coming of the transistor. Wherever electric signals were translated into mechanical motion represented a market for these advanced products. In replacing many discrete components, smart power semiconductors would significantly reduce production costs, power consumption and component failures and, as a result, it was believed, create an instant billion dollar market.

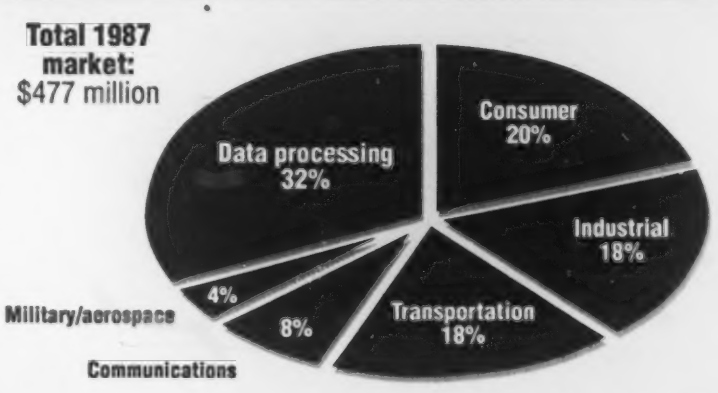
Although expectations have been tempered since then, the market passed through an important threshold last year. Sales were high enough to attract new entrants while established smart power semiconductor makers worked on new applications and profited from existing ones. Unfortunately, because high development costs, technical hurdles, reduced profitability for dedicated applications and formidable existing technology slowed growth somewhat, it will be a few years before smart power chips reach $1 billion in annual sales.

But manufacturers aren't complaining. European and North American suppliers last year shipped smart power products worth $477 million, according to Dataquest, a San Jose market researcher. Leading the pack with $150 million in sales was SGS-Thomson, which shipped its half-billionth audio smart power device in 1987, according to Ian Wilson, marketing manager for SGS-Thomson's power and analog group based in Phoenix. "We are very bullish," says Wilson. "The market is a long way from maturity."

By 1992, the market for smart power devices (greater than 1 amp or 100 volts) will triple to $1.13 billion, according to Dataquest. Another research company, Electronic Trend Publications (ETP) of Saratoga, Calif., is just as optimistic, pegging the 1992 market at $1.45 billion, or 20% of total power supply sales that year. And by 1995, fully one-third of the projected $7.4 billion power supply market will be smart power, as the world heads toward electromechanical obsolescence, ETP reports.

SGS-Thomson and competitors such as Cherry Semiconductor Corp., Motorola Inc. and Sprague Technologies Inc. see smart power moving in two directions in the future. The hottest development area is high-load and/or high-voltage smart power chips — to 1,000 volts and 100 amps — for controlling AC induction motors, telecom relay switches, and electroluminescent computer displays. Today, these types of chips are scarce and not cost effective. However, Siliconix Inc. of Santa Clara, Calif., recently introduced a chip capable of controlling small industrial motors, solenoids and lamp switches.

Applications for smart power devices — 1987



Source: Dataquest Inc.

Multiplexing on its way

Multiplexing is another major development. Theoretically, multiplexed smart power chips would allow a single wire to control and monitor all the electrical systems in a commercial jetliner. Hundreds of smart power chips connected to centralized microprocessors would regulate electrical output to devices in the farthest reaches of an airplane.

The economics are compelling. A single wire would eliminate hundreds of dedicated wires — reducing the cost of manufacturing and the plane's weight and increasing reliability.

More realistic is partial multiplexing, whereby five wires and low-voltage, high-current smart power chips would replace the usual 30 wires controlling various devices in an automobile door. SGS-Thomson, says Wilson, is working on such products.

For now, the action in smart power resides in relatively low- and medium-power chips, which range from 1 amp and a few volts, up to 150 volts and 30 amps. Last year, the largest single market was data processing, including computer peripherals such as disk drives and printers. Ronald A. Bohn, a Dataquest analyst, pegged 1987 demand at $152.3 million. Motorola, with $114 million in smart power sales last year, has focused on up to 150-volt products for the consumer and automotive markets, according to Dan Artusi, director for marketing for power transistors in the company's semiconductor products sector. Motorola's chips are used in camcorders, cameras, compact disc players and other battery-powered consumer goods for which miniaturization is important. "You can integrate a lot into one package," says Artusi, adding that smart power puts less drain on precious battery

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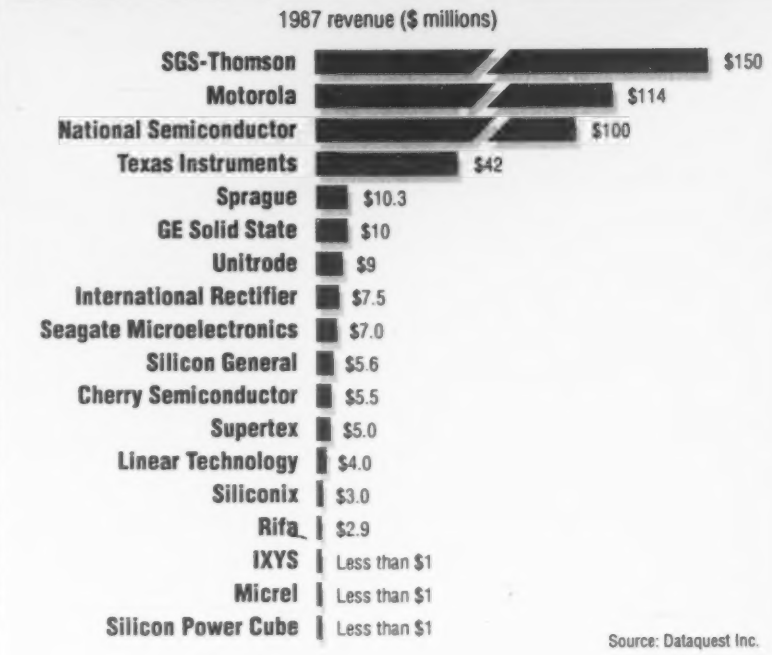
Top smart power IC makers



Source: Dataquest Inc.

power than numerous discrete components.

Sprague Technologies' semiconductor group in Worcester, Mass., ranked fifth in the Dataquest survey, ringing up $10.3 million in sales in 1987. "We play in the under 10-amp, under 400-volt market, [selling to computer peripheral manufacturers and automakers]," notes Bob Frostholm, Sprague vice president for strategic marketing for chips. Sprague is believed to be developing multiplexed products.

As the market moves into the higher load arena, cost will likely separate the winners from the losers. "Either you have to be a very small niche supplier or one of the big guys," says SGS-Thomson's Wilson. The "small" suppliers include new companies such as IXYS Corp., Micrel Semiconductor Inc., Power Integration Inc. and Silicon Power Cube Corp. These companies are pushing the development envelope with new technologies and breaking into the high-voltage, high-current marketplace, according to Bohn. Both IXYS and Micrel, for example, have made advances in combining DMOS and CMOS, Dataquest reports.

In 1987, the smart power technology was predominantly bipolar, representing $336 million in sales. The first smart chip was developed in 1977 by Sprague when CMOS logic was combined with the power bipolar process. But entry into higher power markets will force further merging of bipolar and MOS technologies as well as development of completely nonbipolar technology. By 1992, bipolar will drop to less than half the market of these competing technologies. Among them are: CMOS plus DMOS; BiMOS; bipolar I^2 logic; and BiMOS plus DMOS technologies.

"DMOS is a great technology, but it puts you at tremendous cost disadvantage," notes Sprague's Frostholm. Issues that must be resolved include the need for: better yields; more cost effective packaging; improved technological benefits; and more standards. Developing the new technologies will require heavy capital spending and possible partnerships or, at least, order commitments from major customers such as automakers, Bohn observes. And maybe in a year or two, the initial euphoria will have been justified.

JOHN M. DODGE

Avnet's Tony Hamilton and the rest say they can make 25%-plus on computer sales. Critics claim they'll be lucky to clear 10% — and to escape bitter channel conflict

Why distributors may be wrong to sell computers

BY BRUCE C.P. RAYNER

This summer, top-ranked electronics distributor Hamilton/Avnet, a division of New York-based Avnet Inc., quietly split itself into two separate business units: one division now directs its sales efforts toward the traditional electronic component business, while the other focuses exclusively on selling computer products and systems. The goal for the newly formed computer division is $400 million in annual revenue by July 1989, and over $1 billion by the early 1990s. If realized, this will put Hamilton/Avnet at well over $2 billion in annual sales in a few years.

Earlier in the year, fourth-ranked Hall-Mark Electronics Corp., a Dallas-based distributor, inked a $3 million three-year deal with software vendor MCBA Inc. to market Unix application packages. The move is a significant departure by an industrial distributor into the uncharted waters of combined software-hardware solutions sales. Hall-Mark now acts as a systems integrator by selling the MCBA software in conjunction with Unisys Corp. computer systems. In total, the distributor hopes for $500 million in computer systems revenue by 1991.

Other industrial distributors are hot on the heels of both Hall-Mark and Hamilton/Avnet for a piece of the burgeoning computer systems market. Arrow Electronics Inc. now has three computer products divisions, two from its Ducommun acquisition; British-owned Lex Electronics Inc. sells systems through two U.S. divisions; Wyle Laboratories' Electronics Marketing Group is growing its market share in the western United States; and others are entering the fray by reselling anything from board-level products to complete turnkey solutions.

The push into the computer business by distributors has far-reaching consequences for all companies associated with computer products. For computer and software vendors, it means tapping a powerful source through which new markets can be reached; for the 8,000 to 9,000 value-added resellers and distributors (VARs and VADs) in the United States, it means being forced to develop new relationships and possibly facing new competition; and for the end user it means another option in purchasing equipment.

But the new relationships between computer-systems vendors and in-

Mark Richards/Picture Group

What, me worry? Doyen of distribution, Tony Hamilton: "Good distributors should make in the area of 25%-plus gross profit as we get into 1989 . . ."

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dustrial distributors are fraught with risk. While sales growth may not be in question, profitability certainly is. And channel conflict, where distributors may end up warring with VARs or with direct salespeople, becomes a very real issue. The scenario also blurs the distinctions between computer-only distributors, industrial distributors and "master" VARs.

However, the industrial distributors contend there is plenty of business for them to peacefully coexist with both vendors and other computer resellers. The total available U.S. computer products market is estimated to be worth over $140 billion, sources say. In 1987, the distributors' share of that was still an insignificant $2 billion. However, that $2 billion accounts for close to 30% of total distribution sales and has been growing at close to 40% a year for the past five years. By all accounts, that growth rate is expected to continue.

"The [computer systems] market itself is moving towards two-tiered distribution because the manufacturers are realizing they can't afford to sell to the little VARs," says Steven Bosley, director of the value-added distribution planning service at International Data Corp. in Framingham, Mass. Cases in point are Digital Equipment Corp., NCR Corp. and Unisys, all of which have devised strategies that cut small VARs out of their direct sales loop and give them to distributors (see box).

"Those distributors that are well financed and well managed and have the right perspective will seize opportunities if they can be of service to the supplier and the customer," says Anthony Hamilton, president of Hamilton/Avnet and chairman of parent Avnet. Hamilton should know what he is talking about. Hamilton/Avnet's long-standing relationship with DEC is paving the way for the distributor to do an estimated $500 million in computer sales in fiscal year 1990, ending in June 1991. Hamilton says his company is on track for that target.

DEC's lead

DEC is banking on the success of industrial distributors to penetrate the systems business. For the last 10 years, DEC has relied on distributors like Hamilton/Avnet to supply the end user with board-level products and peripherals. But more recently, the No. 2 computer vendor has expanded its distributors' involvement to include all its systems products except mainframes. And in March of last year, Digital formalized a policy whereby all its VARs that do less than $500,000 annually must deal through distributors.

Part of the reason for the move was because of the changing nature of distribution. Says John O'Keefe, manager of the Indirect Channels Group at Digital: "As we have gotten better at delivering product quickly — now, almost all our products can be turned around in 24 hours — the dependence on a distributor who typically inventoried and then responded quickly is diminishing." That leads distributors into new markets, he adds, including selling value-added hardware systems to VARs and end users.

In all, DEC sells through five industrial distributors: Arrow Electronics' MTI division, GTE Data Products, Hamilton/Avnet, Pioneer-Standard Electronics Inc. and Wyle Labs. Sources estimate that Hamilton/Avnet accounts for over 50% of the total DEC business, while Pioneer-Standard and Wyle together make up close to 40%. DEC does not release figures for its total systems distribution business, but sources put the 1987 total at $360 million.

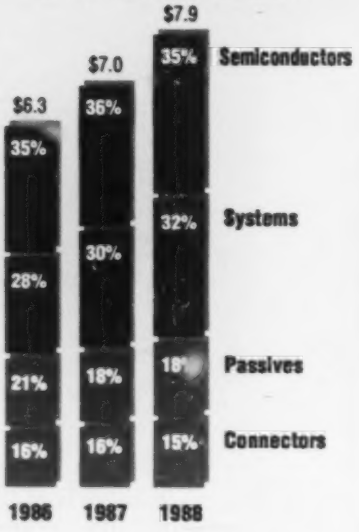
The growth projections of Digital's business with Wyle are "excellent," says James Hunt, vice president for computer products at Wyle. He expects annual growth on the order of 50% in 1988 and 1989. Since 1986, his DEC sales have risen from $20 million to $50 million, says Hunt.

Even though most distributors are publicly upbeat about DEC's year-old policy, some are less than sanguine about results to date. Preston Heller, chairman of Pioneer-Standard, says that since the change, revenue from DEC equipment has not been as material as first believed.

The comments from small VARs prove Heller's point. "I think everyone is taking a look at what DEC did and I think they think that DEC shot themselves in the foot," says a disgruntled Russel Nutter, president of Business Oriented Support Systems Inc., a $2 million a year VAR whose Harper Woods, Mich., business now

Total sales by distributors

By major segment ($ billions)

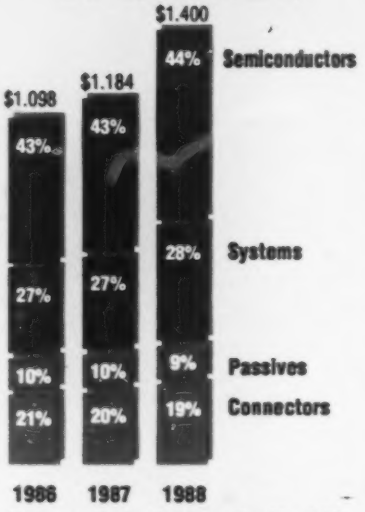


Source: Bear Stearns & Co.

Distributors post steady growth in computer systems sales

Avnet's distribution sales

Sales by segment of Avnet's Electronic Marketing Group ($ billions)



Figures are for fiscal years ending March 31

Source: Avnet Inc.

About 75% of Electronic Marketing Group's sales come from Hamilton/Avnet

According to William Page, executive vice president and head of Hamilton/Avnet's new computer division, margins are currently running slightly above 20%

has to deal through Hamilton/Avnet instead of direct to DEC. "My opinion is that they [DEC] are losing some of the volume from the VAR channel," he adds.

"I would certainly expect some [VARs] to be confused," concedes Digital's O'Keefe, but he is adamant that if they are not getting satisfactory service from their new distributors, all they need do is contact him and he will straighten it out. "We are absolutely committed to getting those VARs the same level of support," he says.

Dissatisfied VARs

But there are other issues besides dissatisfied VARs that Digital and its distributors must face. The initial optimism may have been ill-founded because of the longer sell cycle and the more attention that the customer demands in computer products as opposed to components, comments Paul Zorfass, director of computing research at Boston-based The Yankee Group. This puts pressure on total sales figures as well as profit margins.

Master VARs — big national VARS that sell to smaller local and regional VARs — and other systems resellers operate on thinner profit margins than industrial distributors. Clarke Walser, an analyst at investment brokerage Chicago Corp., is concerned that profit margins in computer systems distribution are not high enough to sustaininvestments in value-added services.

Historically, margins in computer distribution have run from below 10% to the mid-teens, while industrial distributors are accustomed to returns on sales of at least 20%. "I get the sense that distributors are saying to themselves that there is a large number of dollars out there and we need to get a piece of it," says Walser. "But their cost might be too high," he adds.

Other Wall Street observers are equally doubtful about the long-term profitability of distributors selling computer systems. Elizabeth Dorsey, a Prudential-Bache Securities Inc. analyst in New York City, points to figures that show some distributors' gross margins for commercial computer products dropping below 10%. She speculates that distributors stepped up their involvement in the computer business in the past few years partly because of lackluster component sales in the 1985-1986 downturn. Computer systems provide a counter-cyclical offset to component sales, she says.

In 1987, distributors' share of the $140 billion U.S. computer market was $2 billion

But Hamilton insists that margins in computer sales are holding their own. "It would appear that good distributors should make in the area of 25%-plus gross profit as we get into 1989 in the computer business," he says. According to William Page, executive vice president and head of Hamilton/Avnet's new computer division, margins are currently running slightly above 20%. Other distributors report slightly lower margins, especially when selling to VARs.

According to Zorfass, Digital's long-term distribution strategy is in for trouble for other reasons. He claims that DEC's business systems sales through distribution will be hit hard by the new IBM AS/400 midrange computer. Zorfass thinks that to get that product to market, IBM will target the third-party channels such as VARs and systems integrators. "We expect to see IBM becoming more active in aggressive distribution channels with both their PS/2 line and the AS/400," he says. Zorfass has seen "early indications" that traditional OEMs and VARs of DEC's VAX commercial systems are starting to look at the AS/400.

Others point to growth in the Unix business as a reason for less than record-breaking growth in distributor business for Digital. Despite the recent Open Systems Foundation (OSF) agreement between IBM, DEC and others, which promises a Unix standard across several vendors' machines, some resellers are hedging their bets. A few of Digital's competitors are claiming their business is benefiting from the confusion.

"Some of the larger VARs are being driven away from DEC and IBM; they're saying they are not going to be locked in," comments NCR's Ernest DeVane, assistant vice president in the OEM systems division. DEC's O'Keefe has a different opinion about OSF: "I actually thing it is going to help," he says, "it supports our commitment to Unix." Just when that commitment will materialize is uncertain.

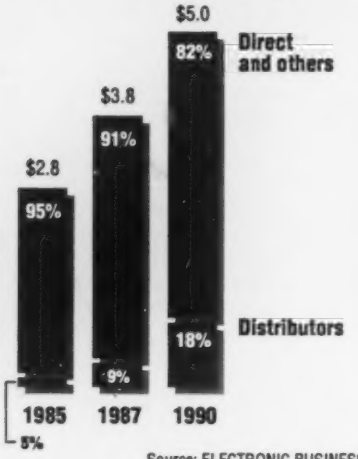
Channel conflict

Distribution problems are bound to arise when channels change. Overdistribution and price wars are common in industrial distribution and the ever-present fear of channel conflict — loosely defined as more than one party trying to sell the same equipment to one buyer — can wreak havoc in any sales organization. And as DEC may just now be finding out,

Mark Richards/Picture Group

DEC's distribution sales

DEC's sales through distribution channels, U.S. calendar year shipments ($ billions)

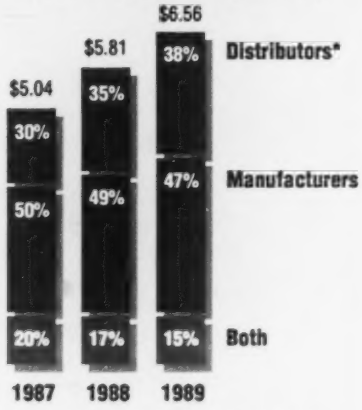


Source: ELECTRONIC BUSINESS and Smith Barney, Harris Upham & Co.

Some vendors are increasing the share of business they do with distributors...

VAR computer purchases

Survey results of where VARs buy their primary processors ($ billions)



* Distributors include all suppliers other than manufacturers

Source: International Data Corp.

...while VARS are turning to distributors for more of their computer purchases

loyalty to a vendor is sometimes strained when smaller VARs get palmed off to distributors.

It does not stop there. In the world of the middleman, industrial distributors are not the only ones vying for a piece of the pie. "The systems distributors are broadening their product line to include some of the things that the industrial distributors have and some of the industrial distributors are moving into the systems distribution line," comments Jerry Martin, president of First Computer Corp., a $10 million computer distributor in Burr Ridge, Ill.

"The key in any conflict, be it between direct salesforce and distributors or VARs or resellers or whatever, has a lot to do with two items: one of which is definition of responsibility and the other is compensation," comments Jack MacDougall, director of worldwide reseller programs at Prime Computer Inc. As long as the direct salespeople know their territory and are paid enough to pass unwanted sales leads on to distributors or VARs, then all should be well.

One vendor that is serious about minimizing channel conflict is Texas Instruments Inc. According to some VARs, TI's commitment to avoiding channel conflict is held in high regard. The vendor does not allow any of its distributors to deal directly with the end user, and all VARs are contracted to add value of at least 30% to the system they sell. Also, TI's direct salespeople are paid 150% commission (that is, one-and-a-half times what they would make if they sold direct) to do referrals of second-tier VARs and distributors, says Wendel Harrison, the marketing manager at TI's Computer Systems Division.

Now that distributors have the green light from DEC to sell into the end-user market, the potential for distributor-to-distributor and distributor-to-VAR channel conflict could increase. Pioneer-Standard's Heller calls the end-user market "an explosive possibility" but insists that

A sampling of third-party distribution systems

Different computer vendors have different ways of dealing with distributors. Some, like Digital Equipment Corp., have a long-standing relationship with industrial distributors, while others, such as Hewlett-Packard Co., prefer to have nothing to do with them. Here is a sample of some vendors' third-party distribution systems:

- **Altos Computer Systems** does not have a direct salesforce. Instead, it deals either directly or indirectly with over 1,000 value added resellers (VARs), as well as with five regional and two national distributors. The two nationals are Arrow Electronics Inc. and MicroAmerica Inc. Over 50% of U.S. sales come from distribution. Altos' goal is to build the distribution network up to between eight and 10 distributors in total.
- **AT&T** employs seven value-added systems distributors including Ducommun Data Systems, a division of Arrow Electronics Inc., to distribute its Unix-based minicomputers. It also uses Master VARs that can sell either direct to the end user or through VARs. To avoid channel conflict there are very rigid limits on how a VAR can deal with a distributor or Master VAR.
- **Hewlett-Packard Co.** sells its technical and business computer systems either directly or indirectly through VARs. There are no plans at this time to add any distributors to the third-party salesforce, but "eventually it could include some distributors," says a spokesperson.
- **Data General Corp.** is in the process of reworking its strategy on all channels, says John McGlone, director for channel marketing at Data General. The resulting structure could include distributors, but McGlone is noncommital. Currently, about 50% of all sales go through VARs.
- **Digital Equipment Corp.** has a number of channels, both direct and indirect, including a growing relationship with industrial distributors. In March of 1987, a $500,000 lower limit was placed on VARs that could deal directly with DEC; all others now must go through distributors. The primary distributors DEC uses are Hamilton/Avnet, Arrow Electronics, Lex Electronics, Pioneer-Standard, GTE Data Products and Wyle Laboratories.
- **NCR Corp.** sells to OEMs, VARs, master VARs and through distribution. The VARs have to sell at least $400,000 a year, or else they must buy through distributors.

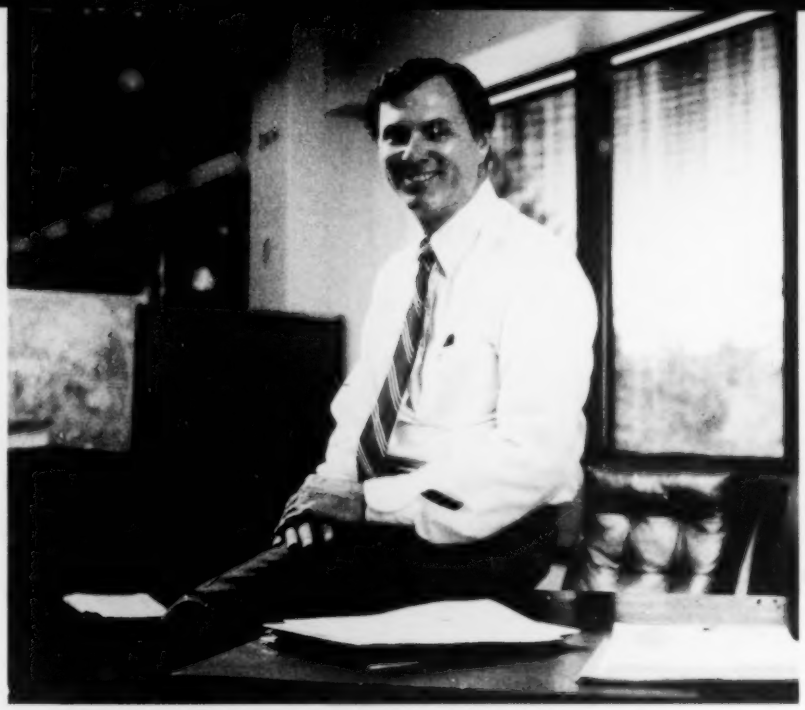
there is no overlap between VARs and distributors. The company currently expects systems sales to provide over 30% of the $425 million in sales it anticipates for this year.

Typically, says Heller, VARs have well-defined vertical markets that require a significant amount of value added, usually in terms of software support. This is not the main market targeted by distributors. However, Pioneer-Standard is developing relationships with software houses that would enable the company to penetrate vertical markets.

Hamilton/Avnet's Page is equally reticent to admit any conflict with VARs. He insists that it is not company policy to get into the applications software writing business. But Hamilton/Avnet is developing partnerships with software companies at this time that, like Pioneer-Standard and Hall-Mark, could mean a new vertical focus for the company. "We do know that selling together with software experts has value and we expect to do more and more," says Page.

Channel conflict could also be a problem between Digital's own salespeople and distributors, says Bosley at IDC, as Digital puts more emphasis on selling jointly with systems cooperative marketing program (SCMP) participants, a fancy acronym for big resellers that sell applications with DEC's salesforce. "The success of those programs will in effect take business away from distributors," Bosley says.

Digital's O'Keefe refutes the claim that distributors will suffer. "You want to be careful you don't overdistribute," he says, "but we are nowhere near that right now." Overdistribution and competition based on price alone is a certain formula for disaster, and most vendors are sensitive to the need to maintain prices. According to O'Keefe, there are two ways to avoid plummeting street prices: first, make sure distributors compete on more than just price (i.e. value added); and second, do not offer extensive discounts. O'Keefe insists Digital does both: "Our street price has been real solid over the last three to four years," he says. □



Dilip Chauhan

Gimme distributors that can add value. Says DEC's John O'Keefe, "Dependence on a distributor who typically only inventoried and then responded quickly is diminishing"

NCR has four regional distributors and one national distributor that sell its Tower computer family, terminals and some printers, says Ernest DeVane, assistant vice president at the OEM systems division at NCR. Distributors can sell either to the end user or through VARs as they choose.

• **Prime Computer Inc.'s** mature 50 Series and the new EXL Unix microcomputer are both sold by the in-house salesforce as well as indirectly through Master VARs and VARs. The EXL's Master VAR program is just getting under way and will include about 12 participants by the end of this month, says Jack MacDougall, director of worldwide reseller programs at Prime. None of those Master VARs will be allowed to sell directly to the end market. As for distributors, Prime does not deal with any at present, but if a low-end system is marketed, then the vendor could be on the lookout, says MacDougall.

• **Texas Instruments Inc.** does not deal with any industrial distributors, but does sell through six 100% computer distributors and over 300 VARs. Direct VARs must do at least $500,000 annually in systems sales and add 30% of the value to the end user in order to qualify for direct service from TI. Distributors must do $1 million and cannot sell directly to the end user. The distribution program was introduced in May of 1987 for the new System 1000 and augments the distribution system in place of the older 990 business system, says Wendel Harrison, division marketing manager for the Computer Systems Group at TI. He does not rule out future use of distributors.

• **Tandem Computers Inc.** is a niche-oriented vendor in the fault-tolerant and on-line transaction processing business; it does not currently use distributors. Its channels include direct sales, VARS, systems integrators and Master VARs. Tandem views distributors as too commodity-oriented for its product offerings. However, the company has recently been contacted by two large undisclosed national distributors and is currently evaluating that channel, says Robert Cronin, manager of reseller marketing programs at Tandem.

• **Unisys Corp.** has been revamping its third-party distribution system since the merger of Sperry and Burroughs last year. As a result, the number of distributors has dropped from about 50 to seven, but that number could grow to 10. National distributors must do a minimum of $8 million in annual business, while Master VARs are required to do over $3 million. Dallas-based Hall-Mark Electronics is both a Master VAR and a distributor. Unisys is in the process of evaluating other distributors. □

Distributors need to be all they can be — for the Army

And for the Navy and Air Force, too. Sweeping changes in procurement policy may mean more military business for industrial distributors

BY BRUCE C.P. RAYNER

In November 1986, Robert Costello, the newly appointed assistant secretary of defense for production and logistics, paid a visit to the Defense Electronics Supply Center (DESC) in Dayton, Ohio, and gave the top brass a glimpse of the procurement shakeup to come. Costello, since named undersecretary of defense for acquisition, has now been given the go-ahead to put his ideas into action.

Two years after that first visit, DESC — the electronics spare parts supplier to America's armed forces — is starting to implement some of Costello's recommendations. It is a slow process, as is everything bureaucratic, but progress is being made. Major changes include two pilot programs that focus on reducing inventory, steamlining the procurement process and improving quality.

These changes have particular relevance to electronics distributors, as they account for over 70% of the orders for the 960,000-plus electronic components that DESC manages every year. In dollar terms, that translates into about $300 million, or about 50% of the estimated $615 million in purchases for the current fiscal year.

Because some products only have single sources, DESC is constantly scouting for new suppliers — particularly those that can ship high-quality products, complete with all mil-spec paperwork, direct to an Air Force base, an Army outpost, or a Navy cruiser in need of parts. "We are looking to do business with as broad a base as we can," commented DESC's commanding officer, Marine Corps Brig. Gen. Richard Huckaby, before his transfer in June. Fellow Marine Brig. Gen. Robert Tiebout succeeded Huckaby at DESC.

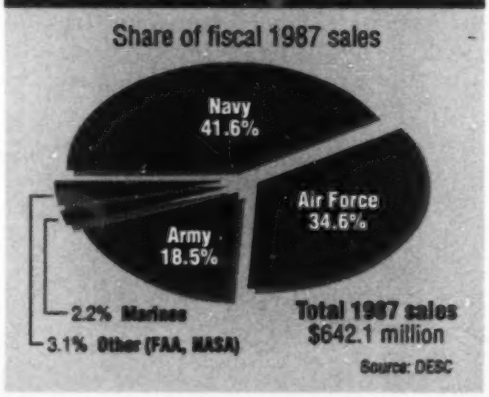
In the past, DESC has done plenty of buying from small business, including distributors. In fiscal 1987, DESC awarded $312 million to small businesses; and $20 million to companies with special considerations, such as being owned by the disadvantaged or by women; out of a total outlay of $642 million. And with the new DOD goal, that 5% of all procurement contracts over $25,000 be awarded to minority businesses, some small minority-owned distributors will benefit. DESC claims that with the new programs, small business will continue to do well.

To a degree, this has been the case, but there is some speculation that for distributor business, it will be the large distributors who will be the long-term winners. In theory, all contracts under $25,000 are set aside for small businesses, but in actuality there are several reasons for DESC's buyers to bypass this requirement — for instance, if the small supplier is not price competitive, or there is only a single source for a particular component.

DESC buys components from...

	Number of orders	Percentage of total DESC expenditures for the year
Distributors	70% - 80%	50%
Others	20% - 30%	50%

... and sells them to:



Paperless ordering

DESC is one of 33 original participants in Costello's pilot contracting activity program (PCAP) to overhaul the procurement system. Besides a number of regulatory changes under PCAP, two additional programs have been put in place that are designed to improve efficiency: the quality vendor program (QVP) and the paperless ordering placement systems (POPS). The QVP allows DESC's buyers to evaluate suppliers in terms of more than just price, while POPS lets the supplier bypass the DESC warehouse and ship directly to the customer.

Although both programs are still in their infancy, DESC claims they will produce significant change. Ideally, it's the integration of these programs into a synergistic procurement policy that will bring the biggest gains. "The quality vendor program allows us to buy with confidence," says Huckaby, "and if we happen to have a paperless ordering agreement with the quality vendor, then we can achieve our goal." The goal is to continually reduce inventory while insuring timely service to the more than 22,000 DESC customers.

Saving taxpayers' dollars is also a

consideration in these times of shrinking defense spending. To this end, DESC is cutting its inventory and consolidating part numbers in an attempt to streamline. For instance, in microcircuits, which include DRAMs and microprocessors, DESC has reduced its purchases by $6 million for the first nine months of fiscal 1988, compared with the same period in 1987, from $27.54 million to $21.68 million. While POPS and QVP are expected to cut costs, neither program is far enough along to have produced hard numbers on the savings to date. However, DESC estimates that POPS will shave 12% off the unit price of the electronic components that the services buy.

As of December 1987, when the program began, five POPS contracts have been awarded to OEMs for a total value of $370,000. Two of these have gone to small businesses for a total value of $207,000. "We are able to reduce the levels in our warehouses to bare minimum levels because the [vendor] is acting as our warehouse facility and we are using his already in-place distribution system," says Robert Knapp, a procurement analyst in the procurement systems office at DESC. The POPS program is designed for short delivery time components with simple test procedures and consistent demand patterns.

Dawson Jones

DESC procurement analyst Eleanor Holland: In pursuit of vendors — including distributors — that can deliver high quality on time

Anyone can play

Besides the five OEMs, DESC is considering 16 other vendors for POPS, seven or eight of which are distributors, says Knapp. These include Avnet Inc.'s Hamilton/Avnet operation, the top-ranked U.S. electronics distributor, and Marshall Industries, another big-league national distributor. Knapp stresses that any distributor, big or small, has the ability to participate in POPS under the DOD's Competition in Contracting Act, but those with a proven DESC track record have the upper hand.

The quality vendor program was set up late last year and allows DESC buyers to make decisions based on quality and speed of delivery as well as price in awarding contracts. "What we are looking for now is the overall performance of the vendor," says Eleanor Holland, a procurement analyst in the procurement policy office at DESC.

If a vendor qualifies for the QVP, it can receive as much as 20% over the price offered by the non-QVP vendor's price (This suggests the cost of poor quality in the past could have been greater than 20%.) To qualify, the vendor must have delivered three contracts totaling $10,000 worth of product in the last year; it must have a 90% on-time delivery record; and it must have kept quality problems within strict limits.

As of this summer, the pilot QVP has signed up 21 suppliers to participate in four product classes and is working on another five classes. "The value of the program is manufacturing-driven," says Holland, "but the delivery is important, so distributors have a place in the program too." Of the 21 participants, about 12 are distributors, including big-league players Bell Industries Inc., Hamilton/Avnet, Marshall Industries and Schweber Electronics, a division of Lex Electronics Inc. The first two contract awards under the QVP program were made in June to Hamilton/Avnet, and they were munificent sums indeed: a total of just $772.03 for digital microcircuits.

It's worth it to many to be QVP-qualified. Says Ron Moore, general manager at Bell Industries' Dayton, Ohio, military facility, the cost of not being on the program resulted in $50,000 in lost business for a two-month period. Bell came on board with the QVP in June. As a result, Moore anticipates that Bell's market share of DESC business will now increase. But he adds that because of the decline in total DESC purchases, it could mean a lower total dollar volume.

The next stage in the QVP is to expand into other product classes, with the intention of using the program as an incentive to get other suppliers to shape up. "We think that the vendors that are just beyond our criteria will start tightening their belts," says Holland. "Eventually, [QVP] will cover everything we buy," says Holland.

Even though QVP is open to all suppliers, Don Parham, director of military marketing at Schweber, believes that the program will eventually weed out the less proficient distributors, many of these being small firms. Because of the cost of supplying high quality military stock, there is the potential for DESC to consolidate its buying into the hands of a few well-financed national distributors. □

Distributors are back on track after two-year slump

Led by a booming semiconductor demand, electronics distributors' sales are climbing. But a market consolidation could hurt the smaller players

BY DWIGHT B. DAVIS

After two years of being battered by the mid-80s electronics industry slump, industrial distributors struggled back to their feet in 1987. The year finished strongly despite a weak start, with distributor sales surpassing the $7 billion mark for the first time. The recovery has continued this year — thanks in large part to the booming semiconductor sector — and most distributors expect the resurgence to stretch well into 1989.

Based on estimates that the semiconductor industry will grow 25% to 30% during 1988, Prudential-Bache Securities Inc. predicts that distributors will experience a 20% revenue surge this year, up to a total of $8.4 billion. Wall Street's Bear Stearns & Co. is a little less bullish, predicting roughly 13% growth to a $7.9 billion level. Semiconductor sales traditionally account for about 40% of total distribution revenue, although the percentage has been slightly lower in recent years. Prudential-Bache sees the overall market growth continuing at a still respectable 15% rate in 1989, according to analyst Elizabeth Dorsey.

Other observers expect somewhat lower growth next year, based partly upon widely held assumptions that 1989 may play host to a cyclical economic contraction. But distributors should be well positioned to continue slow growth even in a recessionary environment, as long as they are better able to manage their inventories than during the previous downturn, says Toby Mack, executive vice president of the National Electronic Distributors Association (NEDA).

In any case, a general economic slowdown may not be as important to distributors as the simple issue of component supply and demand, notes Mike Worfolk, president of Schweber Electronics. He points out that most of the growth in the first half of 1988 was fueled by product shortages and increased prices, not by higher levels of unit shipments. Given that component supplies are expected to improve toward year-end and into 1989, Worfolk expects growth in the 5% to 10% range in 1989.

Gross profit margins, meanwhile, hovered around 23% in 1987, Dorsey says, below the 25% margins typical in strong years. Profit margins should approach their traditional levels this year, she predicts, due in part to the continuing DRAM shortage, keeping prices of that key commodity high. As a caveat to this predicted improvement, however, Dorsey notes that an increased reliance on systems sales with their lower margins could adversely affect overall profits.

Downward pressure could also be exerted on margins as more suppliers attempt to cut their costs by reducing the number of OEM customers with

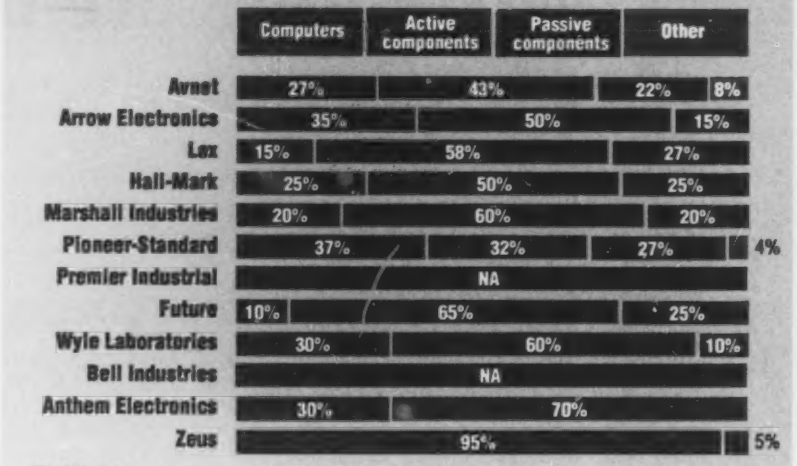
Economic slowdown may not be as important to distributors as the simple issue of component supply and demand, says Schweber president Mike Worfolk

Jon Allan Lewis

which they deal directly, says Tom Calder, vice president for marketing at Marshall Industries. "As these suppliers turn more to industrial distributors, competition in the field will increase," he says, "and that will keep margins tight."

While distributors believe the worst is behind them, the 1985-86 recession has had a lasting impact on the nature of their business. Gone are the days when the companies could profit by doing little more than stocking large inventories and providing one-stop shopping for OEMs and other value-added resellers. Suppliers are now demanding that the middlemen keep them better informed about shifts in customer demand. At the same time, "Our customers are energetically trying to reduce their expenses by calling upon us to perform a variety of value-added services," says Anthony Hamilton, chairman of Avnet Inc.

Top distributors — Product breakdown



FY 1987 data

Source: ELECTRONIC BUSINESS

Market restructuring

These market demands have begun to alter the basic character of the distribution business. Market consolidation has accelerated as the players attempt to gain greater economies of scale, more diverse product lines, and broader geographic representation. At the same time, the major distributors are branching out by providing value-added services such as component customization, testing and inspection; by setting up electronic data interchange (EDI) connections with their suppliers and customers; and by increasing their activity in the fast-growing systems sales marketplace.

The just-in-time production philosophy is playing a key role in much of this restructuring. OEMs and other integrators are looking to cut their inventory costs by keeping on-site stocks at a bare minimum. As such, they're relying upon distributors to keep the necessary components and peripherals in their warehouses ready for immediate shipping to keep the production pipeline flowing. To further expedite this process, many distributors are setting up "in-house stores" at their customers' sites. The distributor owns these inventories, but the customer agrees to maintain them on-site for rapid availability.

JIT arrangements not only require that the distributors provide all necessary components at a moment's notice, but that the parts arrive at the customers' doors error free. To meet this demand, distributors have beefed up their quality control and inspection departments, removing these responsibilities from their customers' shoulders.

Another related service, that of "kitting," is also much in demand. Kitting can range from simple prepackaging and shipment of related groups of components to actual subsystem assembly and programming. Schweber's Worfolk notes that the term "preproduction" might better describe the kitting operation. "We can source the production and deal with the 30 to 40 vendors supplying parts rather than have our customers perform that task," he explains.

Distributors hope for a 15% to 20% surge in revenue and better profit margins

Communications networks

To efficiently manage these expanded activities, distributors are setting up on-line connections between themselves and their suppliers and customers. Through such EDI programs, "we're working to facilitate the information flow," says Hall-Mark Electronics president Joe Semmer. "Our customers load us up with orders, and we, in turn, load up our suppliers with orders."

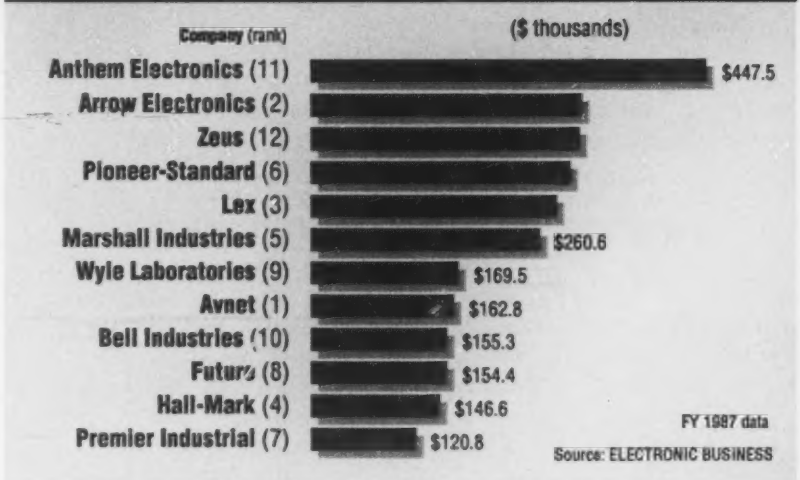
So far, though, most EDI setups consist only of customer-site terminals linked to the distributors' mainframes. While these facilitate ordering and the transfer of technical product information, they fall far short of the full potential of EDI, says Worfolk. That potential will only be realized through the advent of mainframe-to-mainframe links that will let customer and distributor host computers communicate directly, he says. Such links will further augment ordering and invoicing automation, but they must wait until EDI communications standards are hammered out by groups such as the American National Standards Institute.

Even with the growing emphasis on electronic links between the parties, the distributors still lack good methods with which to monitor and analyze fluctuations in supplier and customer inventories, says Mack at the NEDA. As long as this is the case, he warns, the industry will be vulnerable to rumors about impending parts shortages and to the double and triple bookings that customers place to protect themselves when supplies get tight. "A better tracking model would go a long way toward damping out the wide inventory gyrations that have occurred in the past," Mack says. ▷

For their part, distributors are struggling to maintain market share and improve profit margins in a dynamic business that is increasingly dominated by a few large players. Longtime leader Avnet accounted for about $1.3 billion of the industry's $7.4 billion total sales in calendar year 1987, up 12.1% from the previous year's revenue.

Avnet's Hamilton/Avnet division hopes to hold its lead in part through a restructuring move that separates its electronic components business from its growing computer systems and peripherals business. The company has virtually completed a major inventory centralization, with a flagship "megawarehouse" in Chandler, Ariz. Also in Chandler is a new IBM 3090-200E mainframe, which is being networked to the company's 4,000 nationwide terminals.

Top distributors — Sales per employee



Small firms get squeezed

"The ability of the large distributors to feed off a few centralized warehouses permits them to set up simple sales offices rather than complete inventories around the country," notes Fred Wolf, an analyst with Mabon, Nugent & Co. "This gives them better cost efficiencies and may result in the squeezing out of some of the smaller distributors," he says.

Arrow Electronics Inc. also increased its revenue 12.1% in 1987, to a total of $562 million. The company lost $15.8 million on those sales, but that bad news was quickly mitigated as Arrow successfully completed its acquisition of the distribution units of Ducommun Electronics Inc. this January. If the 1987 sales of these units — Kierulff Electronics, Ducommun Data Systems and MTI Systems — had been combined with Arrow's, the resulting revenue would have totaled about $940 million.

The success with which Arrow has combined its new and old operations has surprised competitors and analysts alike. The company's average daily order rate rose from $2.6 million during 1987's fourth quarter to $4.6 million in this year's first quarter. That rate surpassed the combined preacquisition order rates of the two companies, and analyst Dorsey believes Arrow should easily attain its stated goal of reaching $1 billion in revenue this year. "They've

Top U.S. electronics distributors

1987 rank	Company	Calendar year distribution revenue ($ millions) 1987	1986	Percentage change	Distribution as a percentage of total company revenue	FY 1987 revenue ($ millions)	FY 1987 pretax profit ($ millions)	Pretax profit as a percentage of total revenue	FY 1987 net income ($ millions)
1	Avnet	$1,285	$1,146	12.1%	77%	$1,547.1	$46.6	3.0%	$22.8
2	Arrow Electronics[1]	562	502	12.1%	100%	562.4	-15.8	-2.8%	-15.8
3	Lex[2]	541	501	8.0%	23%	541.0	5.6	1.0%	NA
4	Hall-Mark[3]	475	385	23.5%	43%	1,099.5	30.1	2.7%	16.8
5	Marshall Industries	356	269	32.1%	100%	286.6	11.0	3.8%	5.1
6	Pioneer-Standard[4]	320	276	15.9%	100%	254.6	8.6	3.4%	5.2
7	Premier Industrial	297	267	11.2%	61%	459.0	81.4	17.7%	48.3
8	Future	270	217	24.3%	100%	270.2	NA	NA	3.0
9	Wyle Laboratories	265	225	18.2%	72%	368.0	10.5	2.9%	5.8
10	Bell Industries	199	158	25.9%	49%	357.1	6.9	1.9%	3.3
11	Anthem Electronics	197	167	17.8%	100%	196.9	9.1	4.6%	5.0
12	Zeus	91	92	-0.7%	100%	89.1	-1.7	-1.9%	-1.0

[1] Acquired Ducommun's distribution business Jan. 1988. If the acquisition had been made on Jan. 1, 1987, pro forma combined sales would have been $940 million
[2] Data for U.S. distribution operations only
[3] Parent company Tyler Corp.
[4] Includes sales of 50% owned Pioneer/Technologies Group Inc. with fiscal 1988 sales of $91.7 million

done an amazing job of assimilating the two companies," she says.

The downside of the acquisition is the further leveraging of the parent company. In 1987, Arrow's debt as a percentage of total capital was 39.5%; after the acquisition it rose to about 66%, according to Dorsey. Arrow had to pay $7.2 million in interest in the first quarter of this year.

Troubling high debt

High debt as a percentage of total capital is endemic in the industry — typically spanning the 35% to 45% range — and analysts warn that distributors might have a hard time financing their operations should another slump occur. Still, this year's strong economic performances should help lower this statistic.

Another factor boosting this year's outlook is the impact of the 1986 Tax Reform Act. In fiscal year 1987, Avnet's net income fell from the previous year — from $23.9 million to $22.8 million — largely because its tax rate rose from 43.6% in fiscal '86 to 51.1% in fiscal '87. For the fiscal year closed June 30, 1988, Avnet's rate fell to about 39%.

No. 3 distributor Lex Services Plc announced a major restructuring of its Schweber Electronics division in mid-July. The changes include realignment of the firm's five regions and the establishment of sales and marketing, technology, regional services and operations managers for each region.

The fourth largest distributor, Hall-Mark, went against the consolidation trend in early July when its management team announced a plan to buy the company from parent Tyler Corp. Previously, Hall-Mark had been the subject of much takeover speculation. At press time, the deal had been signed, but not yet finalized, according to Semmer.

Fifth-ranked Marshall out-performed the rest of the top companies in 1987, with revenue jumping 32.1% over calendar year 1986 sales. The company continues to rely heavily upon its Japanese sourced product lines; approximately 19% of Marshall's 1987 sales were of Japanese products, making the company the largest distributor of these lines in the United States, according to marketing vice president Calder. □

Top distributors — Net income/total revenue

Net income as a percentage of total revenue	Return on equity	Return on investment	Cost of goods as a percentage of revenue	Sales per employee ($ thousands)	Net income per employee ($ thousands)	Five-year growth (Compounded average annual growth rate) Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Fiscal year ended
1.5%	3.5%	2.6%	73.5%	$152.8	$2.4	6.8%	-16.5%	146.5%	25.7%	6/87
-2.8%	-16.4%	-10.0%	79.4%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	12/87
NA	NA	NA	NA	278.9	NA	20.7%	NA	NA	NA	12/87
1.5%	9.4%	5.8%	74.8%	146.6	2.2	11.0%	13.0%	76.5%	38.4%	12/87
1.8%	9.4%	5.1%	75.1%	260.6	4.7	19.4%	NM	143.7%	45.7%	5/87
2.0%	15.4%	5.8%	75.2%	296.0	6.1	16.5%	53.7%	27.5%	62.5%	3/88
10.5%	18.1%	17.6%	51.5%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	5/87
1.1%	NA	NA	NA	154.4	1.7	25.0%	-5.1%	NA	NA	12/87
1.6%	6.5%	4.3%	76.7%	169.5	2.7	13.4%	NM	49.1%	33.5%	1/88
0.9%	3.1%	2.4%	75.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	6/87
2.5%	7.3%	6.7%	76.7%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	12/87
-1.1%	-5.9%	-2.4%	76.6%	304.1	-3.3	14.9%	NM	-461.6%	59.1%	9/87

NA = Not available
NM = Not meaningful

Source: ELECTRONIC BUSINESS

Services get the job done and can save time and money

The "not invented here" attitude has long ruled U.S. manufacturing. But electronics companies now are looking outside for design and assembly

BY ALBERTO SOCOLOVSKY

Uncle Sam knows it. The General Accounting Office told him so. Executives in the electronics industry know it, too. Outside services can do many jobs more cheaply and efficiently than if done in house. This represents quite a change for the electronics industry, famous in the past for shunning anything NIH — "not invented here." Moreover, readers of ELECTRONIC BUSINESS told us in a recent survey that they will be using more services in the future.

There are two main forces driving the trend toward expanded use of outside services. One is internal: many companies are following Allied-Signal Inc. and Honeywell Inc.'s example in downsizing by eliminating operations not critical to their major revenue sources. As a result, they must look beyond their walls for skills and capabilities they no longer have.

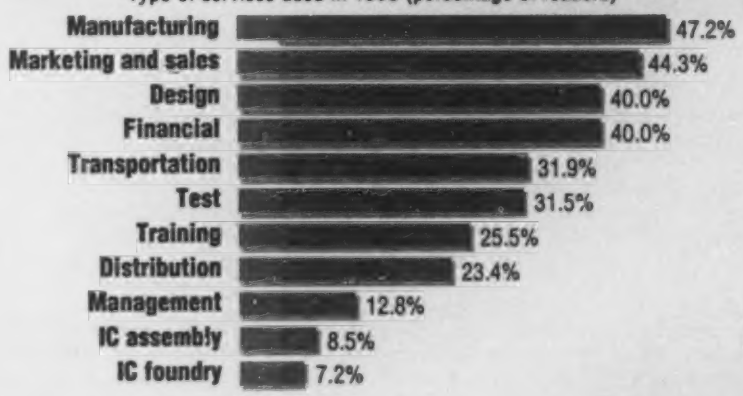
The other force is external: services work very hard for your money. They may also supply you with talent, skills and information that is either unavailable or too expensive if provided by a full-time employee. The market today for services to the electronics industry — ranging from contract assembly, design and distribution to executive recruitment, information services, management consulting, marketing, sales and training — is conservatively estimated in the $15 billion range.

The largest, and oldest, services are contract assembly (used by almost half of our readers) and sales representation. Design is close behind. But, according to our survey, the fastest growing sectors are IC assembly, followed by IC foundry services. Increasing popularity of ASICs is likely the main reason behind this trend. Companies design these chips themselves — or contract with a design service. They then send the designs out to a foundry. And the fabricated wafers are sent off to an IC assembler.

As more of our readers use services, they become more selective. Consequently, service providers must become more sophisticated and better capitalized. The largest service segment, contract assembly, is already being consolidated. Intense competition from domestic and foreign companies has forced United States-based assemblers to seek economies of scale. Capital investment requirements, meanwhile, are increasing for both manufacturing and design. This is especially true in assembly of surface mount components and design of ASICs. Many service companies, however, are small and specialize in labor-intensive operations. They cannot raise the massive capital required to automate. They, therefore, face extinction or, if they have valuable customers, absorption by a larger competitor.

Services used by ELECTRONIC BUSINESS readers

Type of services used in 1988 (percentage of readers)



Source: ELECTRONIC BUSINESS

IBM is the model

Many electronics firms have used IBM as a model, but few followed the computer giant's lead in the early 1960s by subcontracting the assembly of power supplies. More copied Big Blue a decade later in subcontracting the interconnection of computer backplanes, a laborious chore of stripping and wrapping wires from connecting point to connecting point. But it wasn't until the early '80s that contract assembly came into its own. Then, IBM gave major contracts to SCI Systems Inc. in the United States and to Thorn-EMI in Europe. They were paid to assemble PC boards. Subsequently, IBM's productivity — judged in revenue per employee — went up more than 15% in 1982 and 1983. IBM gained revenue quickly without having to hire new personnel or build new factories.

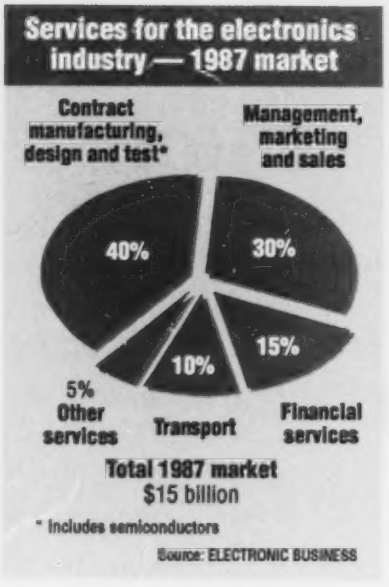
SCI's president A. Eugene Sapp

puts contract manufacturing in the United States today at $2 billion to $4 billion: $500 million of which belongs to his company. SCI's figure, however, covers more than just assembly. "We practice contract manufacturing as a full-service, full-turnkey operation, including the acquisition of materials," says Sapp. "Few do it on that basis."

Express Manufacturing Inc. of Santa Ana, Calif., for example, doesn't do it that way. Express Manufacturing is a $4 million regional assembler with 300 employees. "We work on consignment, providing labor only," explains president C.P. Chin. "That's equivalent to $40 million in turnkey, which includes purchase of materials and testing." Providing labor keeps EMI busy with big neighbor AST Research Inc., the fast-growing manufacturer of personal computers. SCI's Sapp recognizes the advantage of regional assembly. "That's why we're regionalizing our business," he says. "We operate all over the U.S. and in Scotland and Singapore."

Sapp estimates that in the United States, contract manufacturing is expanding as much as 40% per year. This growth suggests that customers are increasing the share of assembly work they give to services. "Many people are rethinking capacity planning," he explains. "We have customers who've moved manufacturing from their facilities to ours — and closed down their operations." SCI has a four-pronged strategy for expanding services: investment in SM technology; providing regional coverage in many geographic regions; signing up key customers; and moving toward more vertical integration. "The trend is to broad-based, multiplant services," says Sapp. The main drawback is that the investment required is constantly increasing. "An SM line costs up to $2 million, just for equipment," Sapp says. Still, he adds, contract manufacturers can amortize such massive investments faster than their customers — due to higher manufacturing volumes at a contract shop. "We've the potential to optimize utilization, rather than just tie up capital," explains Sapp.

Not usually considered assemblers, but performing an important assembly function, are the electronics industrial distributors that offer value-added services. These usually consist



of assembling multipart components such as connectors and potentiometers, a natural service for distributors that have inventory of parts and factory-supplied tools and training. A distributor service now enjoying a comeback, thanks to just-in-time (JIT) programs, is kitting. This consists of delivering groups of components to meet a customer's bill of materials in specified quantities and delivery dates.

Configuration of computer systems is another fast-growing value-added

Contract manufacturing is growing as much as 40% a year

business for distributors. Tony Hamilton, chairman of Avnet Inc. and head of his company's billion-dollar industrial distribution group, estimates that value-added services of all types, including ASIC design, represent 20% of his sales. The figure is lower for other distributors, but the total for their value-added services may be close to $1 billion.

When sleek European imports started taking over the U.S. sports car market two decades ago, the big U.S. automakers recognized that even they didn't have the styling talent required to compete, and went to Italian designer Pininfarina for help. Today, American electronics companies are doing much the same. For instance, the German-American firm Frogdesign, which Steve Jobs hired for the stylish Apple IIc portable computer, also counts Sun Microsystems Inc. and Jobs' new firm, Next, among its customers.

Aside from Arthur D. Little and nonprofit organizations such as Battelle Memorial Institute and Stanford Research Institute, there are few large firms concerned with circuit and product design, the traditional technological bastions at electronics companies. Most are small. "When the product succeeds and the [design] work grows, the customer forms its own engineering department," says Donald E. Pezzolo, president of Diablo Research Corp. of Sunnyvale, Calif., a $1 million firm that helps large, nonelectronics companies apply electronics technology in new places — like the home.

The Electronic Industries Association has awarded Diablo a contract to research power line carriers. The EIA is drafting standards on how home appliances will be controlled through household wiring. Appliance manufacturers are well represented among Diablo's customers. They could start their own engineering departments to design new electronic products. But they figure that they can get to market faster by subcontracting the design.

Letting others sell for you

The Chicago-based Electronic Representatives Association estimates that reps sell $40 billion worth of components, equipment, systems and — you guessed it — services, a year. Assuming an average commission of 6%, the reps' service may amount to $2.5 billion. The group itself is a service organization for sales representatives who perform a marketing service for electronics manufacturers.

Electronics companies, particularly components manufacturers, debate forever the pros and cons of a direct salesforce versus independent representatives. Often, personality is as much a deciding factor as the issues involved. For every rep who tells a story of a product line whose sales withered after the manufacturer hired its own salespeople, there is a manufacturer who claims to have re-

duced his sales cost by going direct. Yet the Japanese chip makers had no trouble recognizing the value of the representatives' service. Their initial penetration, and eventual dominance, of the DRAM market in the United States was spearheaded by sales reps.

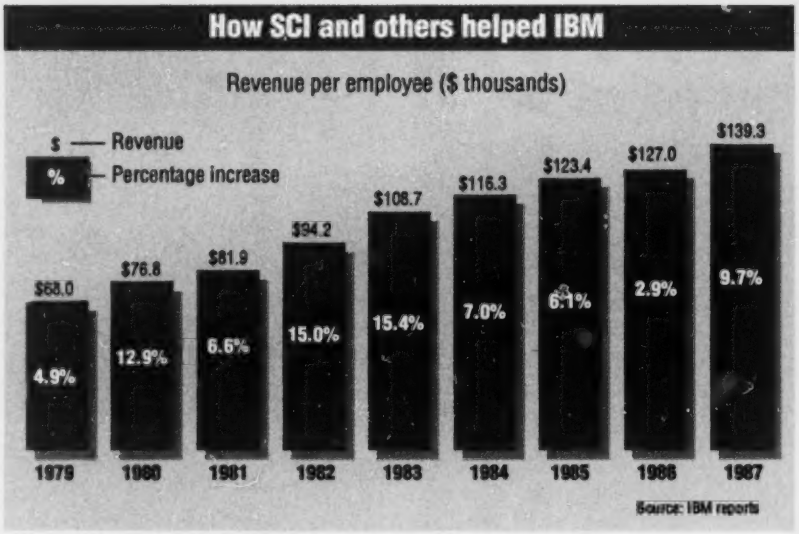
Many small manufacturers look at reps for more than sales help. They depend on them for management consulting — through reps' councils — and for market research. On a more formal basis, these two specialties are a growing market for management consultants and information services.

"Our information service consists primarily of syndicated market research," explains Ralph Finley, executive vice president for strategic planning at Dataquest Inc. of San Jose, probably the largest market research firm specializing in electronics technology and markets. Using an independent research firm has "an economic justification," according to Finley. "In the whole world, there may be a total of 40 specialists in a particular industry segment," he notes. "We can assemble a staff of six to eight of them — we have four just on electronic typewriters — and spread the cost across 100 clients."

Although demand for market information is increasing, Dataquest and International Data Corp. are the only companies devoted to electronics that have grown to respectable size. Most others are below $5 million in annual sales. Consequently, they must stay sharply focused on a narrow industry segment to be profitable. Meanwhile, new research firms, bringing a specialized skill or addressing a specific need, open up shop all the time. One of the newest entries is the Business Research Group of Cahners Publishing Co. Business Research, which has access to readers of Cahners' trade magazines, conducts market research on the acquisition and applications of information technology.

Don't buy, lease

Leasing, states the American Association of Equipment Lessors, is a service that allows business people to focus on what the equipment should do *for them* rather than on what it does *to them*. There are many financial benefits that derive from leasing; some are based on accounting rules,



IBM's big jumps in productivity (in annual revenue per employee) for 1982 and '83 coincide with its shift to contract assembly for its personal computers

some on tax provisions. For computer and electronics companies, however, the most important benefit is that leasing transfers the risk of obsolescence from the lessee to the lessor. Indeed, computers are the leading growth category in leasing, according to the AAEL, with 20.7% of the new leasing business in the United States for 1987. Telecommunications equipment was in fourth place with 9.6%.

"We make it easier to buy and sell," says Edward Herman, chairman and CEO of Equitable Lomas Leasing Corp., a financial services company that specializes in leasing computers, communications equipment, CAD/CAM and ATE to computer and electronics manufacturers. A popular type of lease among these companies, says Herman, is the operating lease. This type of lease meets accounting rule FASB-13, which allows off balance sheet financing, thus freeing the lessee from having to capitalize the equipment's purchase in the company's financial statement. "Under government procurement rules, operating leases provide defense contractors with better cost recovery: the equivalent of a rent," explains Herman.

IC assembly and IC foundry services are the fastest growing service sectors

It is difficult to estimate the dollar volume of leasing services for computer and electronics companies, because most lessors measure their business based on the acquisition cost. Factoring in major manufacturers such as Xerox, which have their own leasing arm, and leading rental companies that specialize in electronic and computer equipment, Herman estimates a volume of $5 billion in such equipment, plus at least a comparable amount for nonelectronic equipment, such as airplanes, which electronics firms lease. "The [leasing] industry average earnings are 14.5% after tax," says Herman. If so, what our readers pay for leasing may be double that, or about $3 billion. But then, this does not take into account the money leasing saves.

Ironically, as electronics companies buy more services, they can also provide more services. They concentrate on solving problems for their customers; not only by selling products but, increasingly, by performing services for them as well. At Digital Equipment Corp., for example, services already account for more than 30% of revenue. □

Why SMT won't give circuit board CAD firms a break

Revolving parts lists, systems integration, and hot spots are just some of the side effects of SMT that CAD firms wish they'd anticipated earlier

BY TONY GREENE

As surface mount technology takes center stage in the printed circuit board design arena, board designers want to be able to take full advantage of the benefits offered by the technology. At the same time, they want to avoid the problems that increased density, closer pin spacing, higher temperatures and an ever-changing library of parts are causing. In short, the designers want computer-aided design programs that are smart enough to handle all these problems and more.

All of which imposes new demands on makers of PCB CAD equipment, who find themselves having to deal with an increasing need for smarter routers; with the growing significance of thermal analysis; the difficulty of keeping parts libraries current; and with a definite trend toward integration of CAD equipment into complete board manufacturing systems.

Surface mount is not a new technology, but after being around for almost 15 years it is now coming of age in a manufacturing environment that wants denser, more complicated printed circuit boards. "At least half of our customers are doing SMT and 70% to 80% of the benchmarks we are doing are SMT," says Bruce Holland, president of Boulder, Colorado-based Cadnetix Corp. With 1987 revenue of $37.7 million in PCB CAD, Cadnetix is the fourth largest player in the PCB layout game, with a 5.2% share of the market, according to San Jose market research firm Dataquest Inc. The PCB CAD market, which is predicted to generate $796 million this year, is expected to grow at a compound annual rate of 5.2%, reaching $930 million in 1992.

The good thing about the recent push toward SMT is that it did not take PCB CAD vendors entirely by surprise. Cadnetix, Computervision Corp., Mentor Graphics Corp., Personal CAD Systems Inc. and Racal-Redac Inc., just to name a few, saw the need several years ago and began developing software that would be able to utilize SMT.

Hot spots

What they did not all fully anticipate were some of the ancillary issues that SMT has brought into the spotlight at the design end — issues such as thermal analysis. Current software allows PCB design engineers to create extremely dense, heavily populated boards, but these boards generate so much heat that they are useless after they are manufactured. Board makers today want to know if a board is going to work long before it has been produced or even before the art work has been done. Because of this, they want programs at the front end, in CAD, to do simulated thermal analysis of printed circuit boards.

Cadnetix's president Bruce Holland: "At least half our customers are doing SMT, and up to 80% of the benchmarks . . ."

CAD companies have come up with two distinct strategies for handling the hot-spots problem. The first is to produce thermal analysis software in house and make it part of the package when customers purchase CAD software. Beaverton, Oregon-based Mentor Graphics has pursued this strategy. "We were told by our customers that almost 50% of their field failure was thermal in nature," says president Gerard Langeler. He claims that Mentor's thermal analysis program, called Autotherm, is particularly fast, and that all of the program's beta sites have bought the program.

The CAD equipment makers' other strategy is to enter third-party agreements with firms that specialize in thermal analysis software — a kind of "leave it to the experts" method. Cadnetix, Computervision and Intergraph Corp. have all used the same company, Pacific Numerix Corp. of La Jolla, Calif., to supply them with the software.

Another thorny PCB design issue is the problem of connecting surface-mounted components to power and ground plans. In the past, with through-hole technology, this was no problem because component pins went through the board and made connections with all layers. Now, with SMT, it is necessary to have "vias" — solder traces that bridge inner layers of the board to make

these connections possible. "To truly take advantage of SMT you must have a good concept of vias: blind, partial and buried," says Andrew A. Perlowski, vice president for electronics for Bedford, Massachusetts-based Computervision, a division of Prime Computer Inc.

Besides being able to bury vias in the layers of the boards, CAD systems must be capable of dealing with closer pin spacing on surface-mounted devices. In the past, it was common practice to run traces between component pins, but now the number of pins on components and the spacing between them has made this very difficult. Components are also being placed on both sides of the boards.

It all adds up to make placement a major factor in the CAD process and to make the autorouter and placement router functions even more important than they've been in the past. "Autorouters and placement routers today have to deal with more data then ever before," notes David DeMaria, director for technical marketing for Racal-Redac of Westford, Mass. Racal-Redac is predicted to lead the circuit board CAD industry in 1988 with $76.4 million in sales and a 10.6% market share.

3-D chess games

On top of this, boards are being designed with more layers than ever before and routers must be able to solve routing problems for all the layers of the boards at the same time. Printed circuit board design is no longer a two-dimensional problem: "You can think of it like a three-dimensional chess game," says Terry Zimmerman, vice president for marketing for Personal CAD Systems, a leader in personal computer-based CAD systems.

Adds Jim Thompson, executive manager of electronic CAD/CAM at Intergraph in Huntsville, Ala.: "Traditionally, the shortest route was the best, but with SMT that is no longer true. Today, routers must be extremely intelligent to get off the top layer and down to where you have to make the connection."

Another problem for CAD equipment makers is the speed with which

Top PCB CAD vendors

Worldwide 1987 revenue ($ millions)

	Hardware	Software	Services	
Racal-Redac	$8.0	$57.8	$10.6	$76.4
Scientific Calculations	16.8	17.3	17.4	$51.5
DEC	34.0	0.0	5.6	$39.6
Cadnetix	17.9	15.4	4.4	$37.7
Computervision	13.5	13.3	10.2	$37.0
Zuken	19.0	12.5	4.7	$36.2
Hewlett-Packard	19.6	9.8	2.5	$31.9
IBM	21.9	3.3	3.5	$28.7
Calay	17.1	8.1	2.0	$27.2
Mentor	11.4	9.0	3.8	$24.2
Sharp	6.8	7.9	1.6	$16.3
P-CAD	0.0	13.6	2.0	$15.6
NEC	7.6	6.2	1.6	$15.4
Fujitsu	10.2	2.6	1.4	$14.2
Sun	12.5	0.0	1.6	$14.1

Total 1987 market $796 million

Source: Dataquest Inc.

Don't ignore through-hole

A wave of surface mount technology has crashed over American makers of circuit board manufacturing equipment — but it's the Japanese equipment makers that have ridden it in. However, U.S. manufacturers are now diving into the SMT equipment business with gusto and success. U.S. sales of SMT production equipment are predicted to reach $377 million in 1988, with the SMT portion of circuit board assemblies reaching 15% of the total market [ELECTRONIC BUSINESS April 15, 1988 p75].

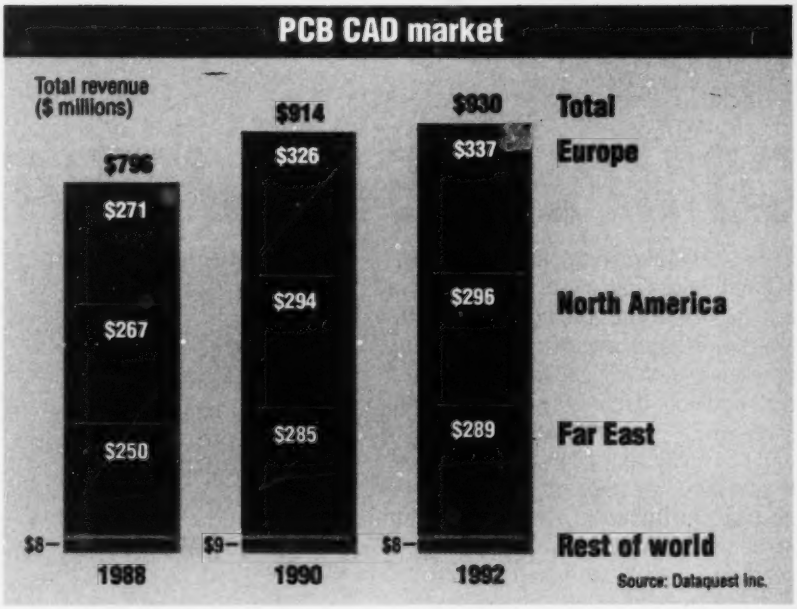
But there's still an ocean of older technology out there. In fact, sales of through-hole machines are paying for SMT development at the big equipment manufacturers, such as Universal Instrument Corp. of Binghamton, N.Y. "We're maintaining a large backlog of through-hole equipment. Through-hole experienced a 10% to 15% growth last year," remarks James Roth, Universal's vice president for marketing and sales. Of Universal's $250 million-plus in sales last year, almost two-thirds was in through-hole gear. But almost all of the 8% of sales that the company spent on product development went into SMT.

Independent analysts confirm that through-hole is not to be written off yet. Charles-Henri Mangin, president of Ceeris International, an Old Lyme, Conn., market consulting firm, says, "We're going to see [steady] sales of through-hole equipment for the next five years; it will always be profitable because the product development cost is already amortized. But U.S. manufacturers need to invest through-hole profits in SMT product development." Why? The market for SMT equipment is growing 40% to 50% annually, according to Mangin, and he expects it to maintain that pace for several more years. □

new SMT devices keep appearing. Parts libraries, which contain symbols for the components that are to be placed on boards and which are purchased with CAD software, can be out of date the day they are purchased. They continue to get further out of date as component makers catch up with the demand for SMT devices.

CAD vendors are coping by making libraries ultimately user-interactive, allowing customers to update their libraries as they need to use a new part. And the vendors are updating their own libraries, on average, twice a year. Another solution is to bring together the CAD system users, to enable them to share their libraries. Mentor is an avid practitioner of user conferences; over 300 people participated in last year's North American users' group meeting, boasts Mentor president Langeler.

Systems integration is another nagging issue. PCB manufacturers want increased access to data at the front end of the design process so that they can use the data generated by CAD to drive manufacturing and test equipment. "Integration is a challenge on the front end and the back end of production," says Langeler. "On the front end, we are coupling with design engineering and on the back end, with testing and packaging. Test engineering is going to play a major role in the future of CAD."



As if this weren't enough, PCB CAD vendors anticipate further demands from the push toward hybrid circuit boards, and from increasing utilization of high-speed chips.

Hybrid boards will take advantage of several technologies at once, such as SMT, buried components and mixes of analog and digital design rules. "We are finding a lot of interest on the West Coast and Canada for hybrid design," says Racal-Redac's DeMaria.

And higher speed components will force the pace. Says Cadnetix's Holland: "New high-speed CMOS semiconductors are going to explode into the commercial board market. It is not going to be a question of how well you handle high-speed design, but whether you can do it at all." □

AOI gets a boost from SMT

Automated optical inspection (AOI) equipment is reaching new heights in the testing of bare circuit boards, helping meet quality demands as the number of board layers climbs and as shrinking linewidths put pressure on conventional electrical testing. Surface mount technology is also pushing manufacturers toward AOI, as optical inspection of outer layers becomes important. Last year the world market for AOI gear was worth about $55 million; it should grow 18% in 1988 to $65 million, according to Dataquest Inc.

The market research firm credits two players with cornering the AOI business: Orbot Inc. of Woburn, Mass., with 1987 sales of $25 million; and neighboring Optrotech Inc., which Dataquest estimates had $21 million in sales last year. "We grew 90% last year and expect to grow 60% in 1988," boasts Paul Manikas, Optrotech's marketing manager. "The industry is maturing and our customers are looking for specific capabilities in AOI equipment," he says. According to Manikas, some customers are buying AOI just to inspect the outer layers of surface mount boards. Others want the AOI equipment to integrate with computer-aided design and manufacturing systems.

But that's not where the bulk of the action is. Says Victor Bunze, marketing manager for another vendor, Visionetics Inc., based in Brookfield Center, Conn.: "SMT is becoming mainstream, but right now the mainstream is in inspecting inner layers." Does that mean more business for more AOI firms? Not likely. As the industry matures and technologies become more complex, the cost of staying in the business is going to become prohibitive for some of the smaller players. "It costs $5 million to $10 million to get a new machine rolling," explains Bunze. "I doubt the industry is going to get any bigger. It's not virgin territory anymore."

Orbot's president Aaron Mankovski agrees that the industry is maturing, as witnessed by the fact that small board makers, those doing $5 million or less in annual sales, are buying AOI. "It shows that AOI is necessary to stay alive in the market," he explains. □

Vision systems vendors sense better profits in OEM sales

Burned by selling to end users who rarely knew what they wanted, makers of machine vision gear are going for 50% gross margins on sales to OEMs

BY SYLVIA TIERSTEN

When their sales to the automotive industry fizzled in the 1980s, machine vision companies had a choice: they could diversify — or they could die. Some, alas, did the latter. The survivors chalked up over $450 million worth of machine vision system (MVS) sales in 1987, according to Bader Associates, a market research firm in Mountain View, Calif.

To replace fading automotive sales, a number of vision companies targeted customers in electronics, food processing and pharmaceuticals. Some of these customers, it turned out, weren't looking for turnkey systems to beef up their production lines. Instead, they wanted a kind of "vision widget;" a relatively inexpensive vision add-on to beef up their product line.

That's why Cognex Corp. backed into the OEM market in 1986. By then, "OEMs were getting pressure from their customers who didn't want to buy their own vision systems," recalls Robert J. Shillman, president and chief executive officer of the Needham, Mass., vision firm. Customers in the semiconductor field, he reflects, "don't want the hassle of vision. What they really want is a wafer prober that works right — or a robot that works right."

Currently, Shillman says, Cognex relies on OEM sales to electronics/semiconductor firms for $4 million, or 80% of its annual business. Cognex makes a high-level, single-circuit board vision system that may be integrated into equipment for on-line gauging, part identification, wafer alignment and identification, IC brand and package inspection, or SMD inspection.

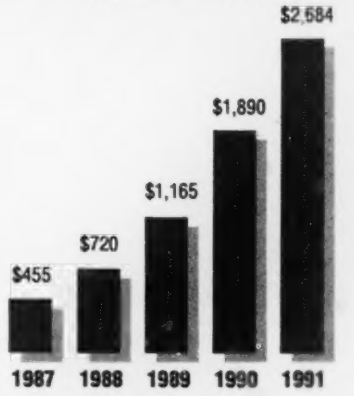
OEM sales, a burgeoning niche in the MVS market, are now a $20 million business, estimates George Gagliardi, president of ImageTech Consulting, in Concord, Mass. Over the next five years, he anticipates an annual growth rate of 15% to 20% in this OEM segment, compared with 10% to 15% for total MVS sales. But that's if you include "captive solutions" in your figuring — or original equipment manufacturers who build their own vision add-ons.

Several MVS companies have been "reasonably successful" in carving out an OEM niche, notes Nello Zuech, president of Vision Systems International, Yardley, Pa., a consulting firm to the automated vision equipment industry. It's a good short-term strategy, he reasons, but vulnerable in the long run. Once OEMs see the value of a vision subsystem, "they inevitably investigate ways of designing and building it themselves," he contends. "Why should they continue to pass that business on to a supplier?"

To succeed as OEM suppliers in the long run, Zuech believes, vision companies will have to do some product innovation on their own, keep prices down and avoid high engineering costs.

Machine vision market

U.S. market of machine vision systems* ($ millions)



* Includes products, fixturing, systems software and engineering

Source: Bader Associates

Beware new tech

Above all, he observes, successful suppliers should watch out for evolving trends. Cognex, he notes, now offers a basic chip set for high-speed alignment with a correlation image processing function. While OEMs currently buy an entire camera system from Cognex, in the future, he muses, they might confine their purchases to the chip sets alone.

Initially, though, an OEM can trim considerable risk, time and cost from the product development cycle by working with an established vision company. When Micro Component Technology Inc. of St. Paul, Minn., sought a "smart" solution for verifying the correctness and quality of marks on IC devices, "we went shopping for existing vision technology," explains David Barnes, general manager of MCT's systems division.

MCT's partner was Itran Corp. of Manchester, N.H., which manufactures in-process vision inspection systems for the automotive, electronic and chemical industries. Bringing the finished product to market took three years — about half the time that MCT would have needed for a solo effort, Barnes believes.

MCT didn't want "a company that tries to be everything to everybody," says Barnes — "a company that gets so caught up in the trap of trying to serve every industry, that it becomes consumed in special engineering and special applications."

Cognex is supplying Angstrom

Measurements, Sunnyvale, Calif., with an automatic image identification and analysis subsystem for a new line of scanning electron microscopes designed for semiconductor wafer inspection. "Cognex had an existing image processing system that was 80% of what we needed, and they worked very closely with us to bring [it] up to 100%," explains Angstrom's president, Lloyd R. Norville. Development took about 15 months, and two units are currently being beta tested. If all goes well, Angstrom plans to buy about 50 vision subsystems a year from Cognex, for a unit price of $15,000.

Another strategy for addressing the OEM market is to focus on more or less generic hardware to fit a broad range of industries and applications. Datacube Inc., based in Peabody, Mass., sells board-level hardware for real-time image processing.

Datacube's market is 80% OEM — "which we feel very comfortable with," says marketing manager Susan Snell Solomon. Gross profit margins for Datacube boards average out at 30% to 35% for boards that are priced in the $3,000 to $5,000 range.

Better bottom line

For OEMs that shoulder specific application development costs, profit margins need to be higher. "They are poor to begin with — and tend to improve over time," says David Wiltbank, vice president for marketing for View Engineering, Simi Valley, Calif. His company, which claims to have installed over 4,000 vision systems worldwide, derives about 6% of its revenue from OEM sales.

"You put a lot of money into an OEM situation to develop the product and exact application for that customer," Wiltbank says. Given sufficient repeat business, margins tend to reach what he calls "reasonable standards" — say, 50% gross, with perhaps 10% to 20% after taxes. Cognex, for one, claims to have realized gross profit margins of 68% or better on many of its OEM products over the past four quarters.

Although prices are characteristically higher for end users than for OEMs, margins on end-user products "typically get gobbled up in support engineering field work," says Joseph E. Campbell, general manager for the industrial controls and machine vision operations at Automatix Inc., in Billerica, Mass. Automatix earns 15% of its revenue from OEM vision engine sales.

Volumes vary from OEM to OEM, but 200 to 500 units a year "can be pretty attractive," Wiltbank says. High-volume sales, however, are anything but typical in today's OEM vision industry. International Robomation/Intelligence (IRI) in Carlsbad, Calif., expects to supply about two vision engines a month for bottle inspection equipment. The OEM customer, Inex/Vistech Technology Inc. in Riviera, Calif., will pay $20,000 per IRI add-on.

OEM sales of vision systems should grow at up to 20% annually

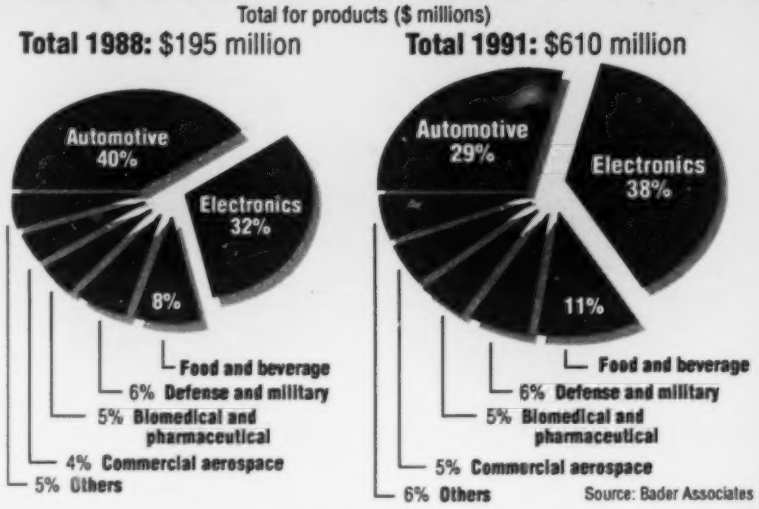
At this stage, 100 units to a given OEM is more than respectable for a vision company — and doesn't tempt the OEM to make the vision component in house, notes Salvatore D'Agostino, director for sales and marketing at Computer Recognition Systems Inc., Ayer, Mass. At 1,000 units, "an OEM might begin to consider it," he says.

However, most vision companies seem unwilling to commit to 100% OEM business. If anything, companies such as View Engineering are moving in the opposite direction. In the 1970s, View's primary business focus was the selling of an alignment device for wire bonding to OEM customers. Singled out by General Motors Corp. for major R&D investment, View reoriented its strategy in the 1980s. "After a while we said to ourselves, 'there are other opportunities in the machine vision business,' " notes Wiltbank. "If we supply a complete system, the revenue is $100,000 to $150,000 per sale rather than $5,000 to $8,000 per sale, and we thought that was the way we wanted to go."

But there are dangers in overreliance on OEM sales. Not too many years ago, IRI had an exclusive contract with GM Fanuc Robotics Corp. of Auburn Hills, Mich., to supply $60 million worth of vision components over a five-year period. IRI realized about $1.25 million in sales before GM drastically cut back on its automation requirements, recalls Donald Mead, vice president of IRI's Automation Systems Group.

Computer Recognition Systems, which derives one-third of its sales from OEMs and two-thirds from end users, considers its current mix highly advantageous. From a technological innovation standpoint, "we like staying in touch with end-user needs," says D'Agostino. "You learn more about the marketplace and can engineer a product better if you are not in an OEM ivory tower." □

U.S. market for machine vision products



Can disk-drive test makers meet the test of time?

Self-testing disk drives are just one of several worries for makers of drive-test gear. Standard test chips may help

BY BRIAN DEAGON

Times are good for the manufacturers of disk-drive test equipment. A boom in hard disk-drive sales has fueled a parallel explosion in sales of disk-drive test equipment, for the simple reason that people want to insure product integrity.

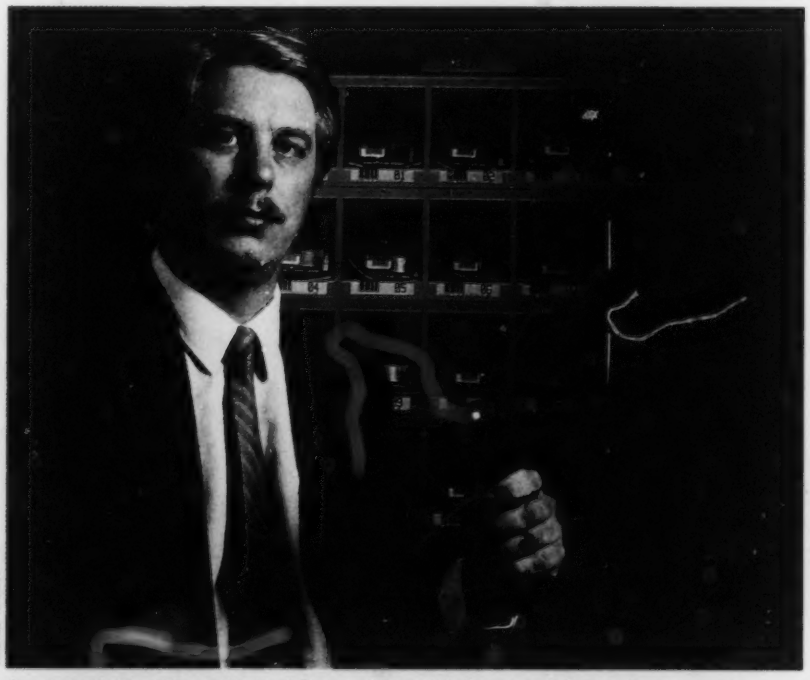
But it's not easy for test-equipment executives to keep abreast of the fast-moving drive industry. As a result, they're being forced to devise new strategies for dealing with self-testing drives, not to mention drive makers that want to get into test equipment markets themselves.

The U.S. market for disk-drive test equipment is projected to grow to $147 million in 1988, compared with $90 million in 1987, according to Peripheral Research Corp., a Santa Barbara, California-based market researcher. However, there will be a significant tapering off of sales by 1991, says Dennis Waid, Peripheral Research president. "We've been filling a big void in microcomputers that didn't have a hard disk drive. Once filled, we see less demand for disk-test equipment," he says.

But this is not the primary threat to greater vitality in the disk-test equipment industry. Technology rolls on, and the testers may have to learn a few new tunes. Several danger signs are out. For one, disk-drive manufacturers are changing the way that computers and disk drives communicate with each other. They're also building more compact disk drives, which places real estate at a high premium. The result is that the pins and connectors placed on the drives to test them are slowly disappearing and the data needed to evaluate disk drives is getting harder to retrieve.

No one is forecasting a quick death for the drive-test gear industry. On the contrary, demand should remain strong through 1990 because of the ongoing boom in disk-drive sales, analysts note. In addition, certain niche markets in the disk-test industry appear safe from any technology changes — disk head recorders and disk certifiers should remain strong, for example, as should sales of disk-test stations and board testers.

In fact, sales of disk-test analyzers — a subset of the disk-drive test equipment market — should grow to about $26 million this year, compared with $22.5 million last year. Sales in 1989 are pegged at $28 million, says Waid of Peripheral Research. Test analyzers peer underneath the skin of disk drives and reveal where the most minute flaws exist. New directions taken in the next few years could spell boom or bust for this crowd.



Michael Grecco

Cambrian's Bert Munnikhuis: "There will need to be more joint venture arrangements with the drive makers. Those that don't [have them] will be out of the loop"

In-house threat

Adding fuel to the fire are in-house development efforts at major disk-drive suppliers and users, such as Control Data Corp., IBM and Storage Technology Corp. The in-house work has already eliminated the need for some to buy drive testers. So a challenge for the drive-tester makers is to build products that are cheaper for customers to buy than make themselves.

"There is concern about the future of this industry. We have to antici-

pate what's coming. We'll change, as long as we have enough notice to do the engineering beforehand," comments George Robinson, president of FlexStar Corp., a Milpitas, California-based maker of test equipment.

The history of drive testing comes from the early days of computers, when disk-drive failure was more common. Most disk drives communicate with computer systems via an interface known as ST506/412, but it is more primitive and prone to failure than newer alternatives. The ST506/412 interface, coupled with unsophisticated disk controllers, forced users to understand why some disk drives wouldn't play. The test industry blossomed as a result.

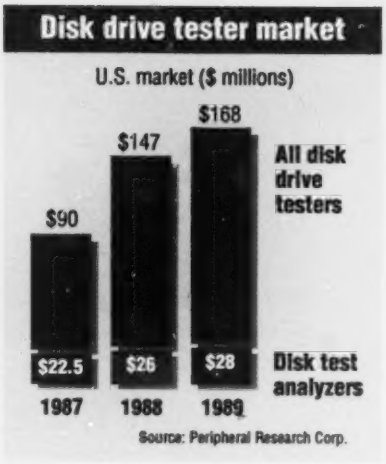
But disk-drive manufacturers have eliminated many of the problems with new, so-called "intelligent" interfaces. These utilize built-in microprocessors that allow more features to be packed into a drive. The most common versions are the Small Computer Systems Interface (SCSI); Enhanced System Design Interface (ESDI); and Intelligent Peripheral Interface (IPI). They contain features that disturb the disk-test equipment industry — like the ability to be programmed to mask technical flaws that exist within the drive. This makes it more difficult for testers to dissect a drive to learn its true behavior.

"We're not thrilled with giving the customer all the test points they used to have," notes Kurt Funch, director for test engineering at Maxtor Corp. in San Jose. Nonetheless, Maxtor has considered ways to build pins and connectors into the drives to allow users more access to data.

Creative use of microprocessors and the shrinking of disk drives are the nemeses of tester makers. And it could get worse. Several major disk-drive vendors fancy building their own test equipment. They also favor building drives that test themselves routinely in order to optimize drive performance.

There is some disagreement in the industry regarding self-testing drives. The drive companies that currently mask data acknowledge that buyers are concerned. For instance, masking errors could prevent a user from recognizing that a drive is slowly deteriorating.

"I believe the systems integrator will want to get at that information," says Stuart Mabon, president and chief executive of Micropolis Corp., a leading drive maker in Chatsworth, Calif. "The complexity of the drive makes it essential for responsible buyers to understand how the drive works and how to diagnose problems."



Unwelcome response

Mabon doubts the disk-drive industry will mask too much data because it could create an unwelcome response from buyers. Still, Micropolis is one of several companies reconsidering the way drives are tested.

Several big drive makers fancy making their own test gear

Others include Conner Peripherals, Control Data, Maxtor, Quantum Corp., and Seagate Technology. These vendors spend millions of dollars on testers. Building intelligent drives with on-board testing capability could be cheaper than relying on outside vendors for testing, although the jury is still out.

However, one problem with achieving this is that the disk-drive industry is much larger than the disk-drive test sector, notes Hank Pselos, sales vice president for Irvine, California-based Applied Circuit Technology, a division of Shugart Corp. "We need to continue to enhance test capability, but a big obstacle has been that the drive manufacturers each have a different way of testing," he adds.

This lack of standardization is an obstacle that many in the industry are trying to resolve. Meanwhile, ACT and several others are trying to work closer with drive makers.

Bedding down with the drive manufacturers will be quite a challenge, industry watchers say. Strategic alliances could evolve into new development contracts to fuel growth.

One successful venture belongs to Cambrian Systems Inc., a Westlake Village, Calif., supplier of media and head testers, servo-writer testers, and disk-drive test stations. Cambrian worked closely with Seagate to build an intelligent disk-drive station able to test 8,000 drives at once during the time-consuming "burn in" process. Cambrian is also talking with Quantum and Control Data.

"The test equipment industry needs to take on another face," says Bert Munnikhuis, Cambrian engineering vice president. "There will need to be more joint venture arrangements with the drive makers. Those that don't [have them] will be out of the loop."

One problem facing the disk-test industry is an unwillingness, or an inability, to invest the money for R&D projects with the large drive manufacturers. There are about 35 companies active in the test area, with an average company size of only $5 million or less.

On the other hand, not all troubles should be placed at the test equipment doorstep. Attempts to standardize disk testing have not been supported by the drive manufacturers. As a result, test equipment manufacturers have to build equipment that meets varying specifications. This, in turn, has created a fragmented test industry.

One proposal is to build a standard test chip into disk drives. In theory, the test chip would allow disk testers to tap into the vital data before it becomes masked. A proponent of this approach is Wilson Laboratories Inc., Orange, Calif., a leading builder of disk-test analyzers. "Our plan is to go to higher levels of testing for intelligent interfaces," says Jim Dietz, engineering vice president. Building test chips would allow access to all the vital data without affecting a drive's data integrity, he notes. □

Taiwan's electronics industry moves upmarket

No longer content to remain the site of cheap assembly, the country is striving toward higher value-added products

To really understand the impact Taiwan will have on the semiconductor industry, you have to know why the country is in transition. For a variety of reasons, Taiwanese manufacturers are heading upmarket across a whole range of industries. They are leaving behind their image as manufacturers of cheap, shoddy or imitation goods.

Korea and Taiwan are often mentioned as exhibiting the same trends, but the driving forces are quite different. Korea is dominated by large, vertically integrated companies — the *chaebol* — with massive government investment and direction for strategic industries.

Taiwan, by comparison, is more like Silicon Valley. You find in Taiwan the same entrepreneurial spirit, the same willingness to trade hard work for business success and the opportunities to make it happen, that you find in Santa Clara. Even Taiwan's version of Wall Street will seem familiar to many of you. There's a red-hot stock market where an entrepreneur can take a company public and become rich overnight.

In response to the overall trade situation, Taiwan has acted in a number of areas: reducing its own import tariffs on a range of products, widening its market to foreign goods and services and spending more on capital-intensive domestic public-works projects. Even boating and coastal fishing are being opened and targeted as tourist attractions.

Currency exchange rates are also changing the nature of many Taiwanese enterprises. Over the past few years, the Taiwan dollar has appreciated dramatically against the U.S. dollar, nearly 20% in 1987 alone. Clearly, Taiwan is losing its edge as a source of low-cost labor.

The government is actively encouraging Taiwanese companies to look for more domestic markets, to find export opportunities in countries other than the United States, to move upmarket to products of greater sophistication with greater added value and competitive worth, and to increase R&D expenses.

BY JAMES E. DYKES

Former president and CEO of the Taiwan Semiconductor Manufacturing Company Ltd., Dykes also headed the semiconductor operations of General Electric Co. This article is an excerpt from a speech Dykes recently gave in Arizona.

The electronics industry accounted for 4.2% of Taiwan's GNP last year and 20% of the value of exports. Planners talk about raising the proportion of such technology-intensive industries from the current 24% to 35% of the manufacturing sector by next year.

You can look at semiconductors as a microcosm of this overall trend.

As you know, semiconductor consumption is a barometer of end-use electronics production. According to Dataquest Inc., of San Jose, last year's total Taiwan semiconductor consumption was about $1.1 billion out of a worldwide consumption of $37 billion. This year, Taiwan's semiconductor consumption is projected to rise by 31.5%, versus 20% worldwide. In dollar terms, Taiwan's share is expected to grow to more than $3 billion over the next five years, for a compound annual growth rate of 22.5%.

The major chip end users in Taiwan are manufacturers of personal computers and associated products and consumer electronics equipment: chiefly VCRs and TVs. Broken down by segments, the personal computer area will show 22.3% compound annual growth in the next five years, followed by the VCR segment at 11% and TV production at about 8.5%.

Two trends here underscore the move upmarket from test and assembly activities: One, the Japanese are moving production of high-performance consumer electronics to Taiwan. And two, the government is encouraging Taiwanese companies to develop their own manufacturing skills in products with high growth potential: CDs, digital TV, digital audio tape.

The semiconductor industry in Taiwan is beginning to blossom. It's interesting to note that although Taiwan's growth as a semiconductor supplier was fueled largely by foreign firms until the early 1980s, the island's first semiconductor factory [for transistors] was started in 1963 by a native Chinese with technology developed at Cheng Kung University.

Following that, of course, there was a virtual explosion of discretes production, beginning with General Instrument Corp., which established a facility for germanium transistors in 1965. That was soon followed by investments in assembly facilities by Texas Instruments Inc. and American Microsystems, and later by a host of others.

By 1984, there were 57 companies and organizations in semiconductors: 13 of them in ICs and 44 in discretes and optoelectronics.

The Hsinchu Science Park [about one hour from Taipei] is home to an increasing number of semiconductor companies alongside other firms engaged in electronics design and production. There are about 70 high-technology companies located there today. The concept is to have semiconductor producers and customers in the same industrial complex.

Taiwan has a combined capability

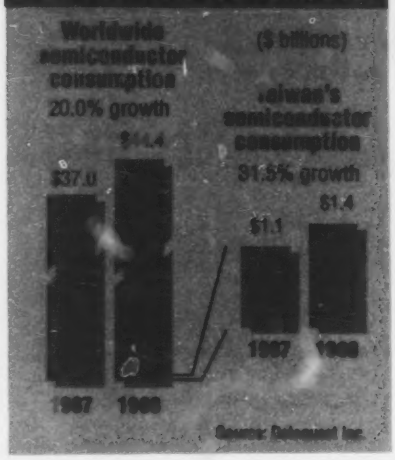
to produce 61,000 4-inch wafers per month now. But with already announced expansion plans, by 1990 Taiwanese producers will have the additional monthly capability for 80,000 6-inch wafers and 35,000 5-inch wafers.

Taiwan's future IC design efforts will likely focus on ASIC circuits and CAD tools. Process options will include submicron CMOS and several others: BiCMOS, CCDs, power ICs, thin-film devices, and gallium arsenide. Package development will be directed at high pincount and multichip, multilayer configurations.

Yet, much work remains to be done for this to happen. If Taiwan is to achieve its IC goals in the next five years, it must develop an infrastructure adequate to serve local industry needs. The most pressing need is for a locally based network of material, equipment and service suppliers to support the growth of the industry.

Let me give you a sense of that projected growth. Winbond is a maker of ICs for the personal computer, telecommunications and consumer electronics industries. It now has sales of less than $35 million, but plans to be a $100 million company by 1991, with 300 employees instead of its current 110.

Taiwan's fast growth in semiconductor consumption



United Microelectronics Corp. is building a new 6-inch fab to add capacity of 30,000 6-inch wafers per month. The firm expects to spend about $140 million over the next three years for capacity additions.

Taiwan Semiconductor Manufacturing Company Ltd. [TSMC] is building a new manufacturing facility in the science park, with a capacity for 30,000 6-inch CMOS wafers per month, although a portion is convertible to 8-inch. The entire facility is designed for submicron geometries, but initial production will center on 1.2-micron feature sizes. We expect it to be operational by the end of next year.

As you can see, Taiwan is growing and maturing. It is becoming a more respected competitor in the world's economy. There are risks and rewards for technology companies that wish to ally themselves with the most dynamic country in East Asia. The risks generally have to do with issues of technology development and availability. The rewards generally have to do with what you might expect from dealing with a proud, talented and hard-working people: quality products at competitive prices. □

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DATA I/O

Computers: In the midst of a drought

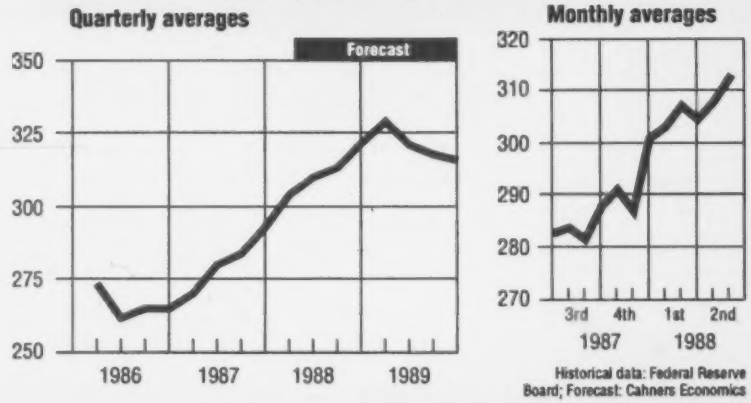
Computer equipment manufacturers are suffering through their own type of drought. Not enough memory circuits to quench the demand. According to *Electronics Purchasing* surveys, memory leadtimes jumped from 8.7 weeks in January of this year to 16.2 weeks in July, as supplies remained scarce. So the upward pressure on prices is on. This may be a factor in the slowing growth rate of new orders for computers and office machinery.

New orders dipped 1.3% in May from an upwardly revised figure in April. Although the $5.3 billion for May stood almost 10% above new orders of a year ago, the growth rate may already have reached its peak. The rising leadtimes and prices may be stretching out demand for new computers. This could slow order growth this year, but on the plus side, throw it into 1989, when supply constraints are expected to ease.

Other indicators for the computer and office machinery industry were optimistic. Output swelled 14% in May over the year-ago level and shipments advanced 15% to total $5.4 billion for the month. Those are right in the ball park of our forecasts. In April, exports of computers and office machines surged 34% compared with April 1987, while imports advanced about 24%. As a result, exports of $1.9 billion outpaced imports of $1.7 billion, leaving a trade surplus for the second month. □

Computers and office machinery — Industrial production

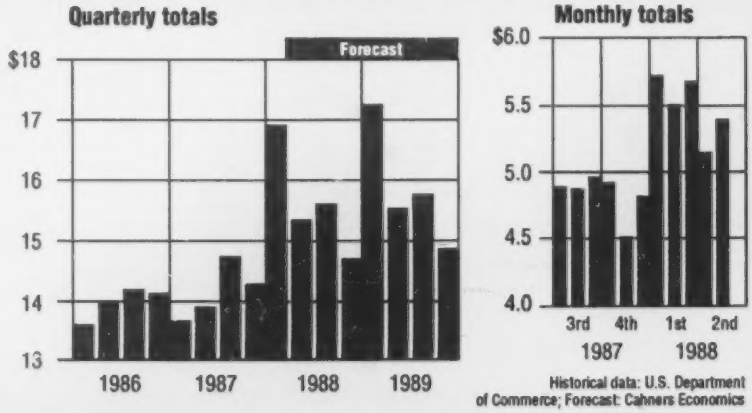
Seasonally adjusted index, 1977 = 100



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Computers and office machinery — Shipments

Seasonally adjusted ($ billions)



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

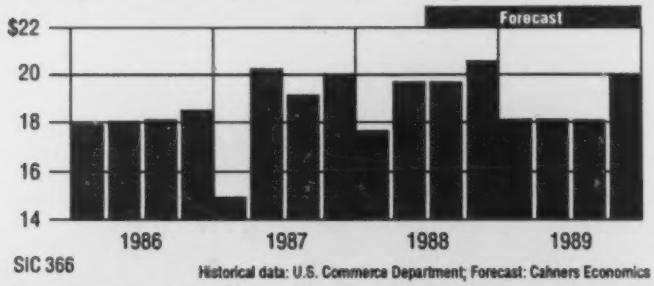
	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, May)	313.4	308.6	+1.55%	274.0	+14.38%	322.9	+2.90%
Shipments (SA, $ millions, May)	$5,402	$5,168	+4.53%	$4,677	+15.50%	$5,189	-3.94%
New orders (SA, $ millions, May)	$5,313	$5,384	-1.32%	$4,846	+9.64%	$5,299	-0.27%
Unfilled orders (SA, $ millions, May)	$18,667	$18,756	-0.47%	$18,980	-1.65%	$18,133	-2.86%
Inventory-to-shipment ratio (SA, May)	1.90	1.97	—	2.09	—	2.00	—
All employees (thousands, May)	504.5	503.7	+0.16%	479.4	+5.24%	489.2	-3.03%
Production workers (thousands, May)	167.3	167.5	-0.12%	159.3	+5.02%	155.0	-7.36%
Exports ($ millions, April)	$1,861	$2,175	-14.44%	$1,392	+33.71%	$1,835	-1.40%
Imports ($ millions, April)	$1,749	$2,051	-14.72%	$1,411	+23.98%	$1,800	+2.87%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

Communication equipment — New orders

Quarterly totals, seasonally adjusted ($ billions)

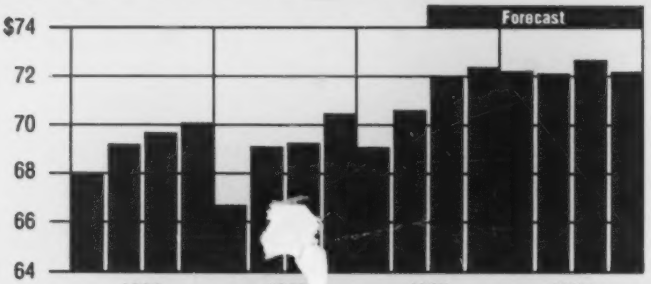


SIC 366

Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Unfilled orders

End-of-quarter totals, seasonally adjusted ($ billions)

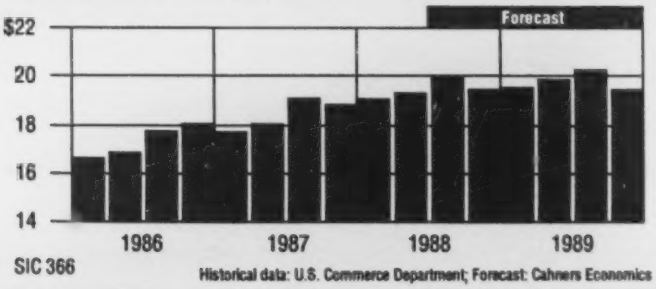


SIC 366

Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Shipments

Quarterly totals, seasonally adjusted ($ billions)

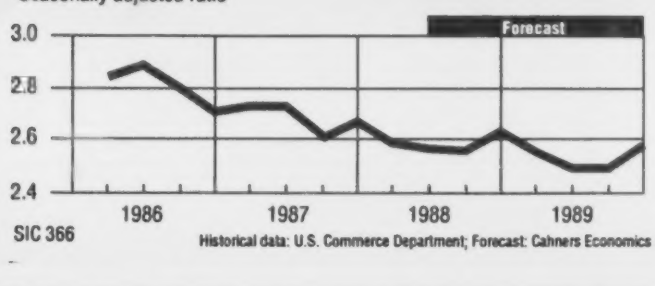


SIC 366

Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Inventory-to-shipments

Seasonally adjusted ratio



SIC 366

Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Good and bad news in communications

The good news for communication equipment manufacturers is that new orders and shipments for the first six months of the year were running about 7% to 8% above the year-ago levels. The bad news is it looks as though growth rates peaked in the first quarter, so the slowdown already has started.

Tapering off in orders and shipments was expected, given the leaner times at the Department of Defense. About 40% to 60% of communication equipment shipments are classified as defense purchases. These are mainly radar, sonar and navigation equipment. Sales of defense-related communication equipment grew at double-digit rates from 1980 through 1986, but since 1983, the growth rate, although still positive, has been shrinking. By the end of this year, defense communication equipment shipments may actually be less than the total for 1987. That would mark the first annual decline since 1975.

An extended Taft freeze through October 1 on new DOD contracting is further tightening the procurement budget. According to the American Electronics Association, one of the areas hardest hit will be office automation equipment and support for information technology and equipment maintenance.

Obviously, the commercial sector has been the driving force for the communication equipment market this year. Measured in constant 1982 dollars, private sector purchases of communication equipment totaled an annualized $36.7 billion in the first quarter of this year. That is an 8% advance over the first three months of last year. But, even in the commercial arena, a softening in orders and shipments growth is evident. Users appear to be hesitant in their buying, even though prices have dropped.

Although growth rates are dwindling in the nondefense sector, they won't fall into the negative zone, even during the overall economic sag next year and in early 1990. This crawl will keep sales of communication equipment heading up. Look for sales increases of about 5% in 1988 and 1% to 2% next year.

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SIX DOLLARS

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

OCTOBER 1, 1988

BLAME IT ON RIO

Brazil's tough stance on imports

PAGE 46

Contract designers' credo: Design and deliver—fast PAGE 14

Look who paid no taxes to Uncle Sam in 1987 PAGE 62

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 19 OCTOBER 1, 1988

PAGE 46 Brazil: The world electronics market would like a piece of the action

COVER STORY/STRATEGIES

46 Blame it on Rio: Brazil's tough stance on imports

With a rapidly growing population of 160 million people and a land mass bigger than all of Europe, Brazil is poised to be one of the major economic forces of the next century. But an economy crippled by runaway inflation, incredible poverty, and internal political struggles jeopardizes that future. So the country's hopes are pinned on the bright spot in Brazil: an electronics industry, which many believe to be the fastest growing in the world today.

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Cover photo: Claus Meyer/Black Star

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Designer labels

In the 1930s, American industrial design hit new highs as champions of the aesthetic approach — super-designers like Raymond Loewy — made form just as important as function. The approach was so successful, so emblematic of industrial vigor, that Loewy in particular was labeled as *Time* magazine's "Man of the Year" in the late 1940s.

In recent decades, though, American product design has hardly been something to be proud of. It's often safely conservative and frequently look-alike and boring.

But we're pleased to report that there are specialty design houses that are out to change the look of American products. Firms like Frogdesign, which gave Apple's Macintosh its unique eye appeal, and Theta Resources, which is sculpting sleek new shapes for mainframes.

And we're happy to note that these contract designers are doing more and more to help out the U.S. electronics industry, not only when those jaded blueprints need an artistic overhaul, but when a new product needs to be rush-designed, or designed to cost.

As our new assistant editor Tony Greene found out, shrinking product life cycles are encouraging American electronics firms to look outside for expert design. Turn to our "Business Trends" story to find out what contract designers can do for you.

Latin lure: Brazil's electronics market

Rio — Stat!

In our cover story on Brazil's huge electronics markets, we're not recommending that vendors race off to Rio at once in search of a fast buck. But we are, we hope, indicating that it may be worth taking a closer look at what some say will be the world's fifth-largest electronics market by the year 2000. We sent associate editor Valerie Rice down to Rio to interview local electronics executives, resident U.S. firms and government officials, and she brought back perhaps the most comprehensive view yet published of Brazil's fiercely protected electronics industry.

Tax tables

No apologies from us for listing, alongside our tables of the top taxpayers in the U.S. electronics industry, a sampling of the firms that actually got tax rebates from Uncle Sam last year. Our editorial judgment, you see, is that there's a very human fascination with who bested — and who was bested by — the IRS that everybody loves to hate. This alluring information is backed by a thorough article on tax tactics by associate editor Bruce Rayner.

JOHN KERR, managing editor

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BPA ABP

The tax man giveth . . . and he also taketh away

The Treasury Department is poised to rule on a tax issue that could mean U.S. companies will pay more taxes on foreign sales

Just as corporate America is settling down to life in a post-tax-reform world, another tax change hits the fan. But unlike 1986, when legislative changes were all the rage, this time around the Internal Revenue Service is bent on reinterpreting a section of the tax code. The result will most likely mean that, under certain conditions, exporting companies will end up paying higher taxes. Electronics companies are at the center of the debate.

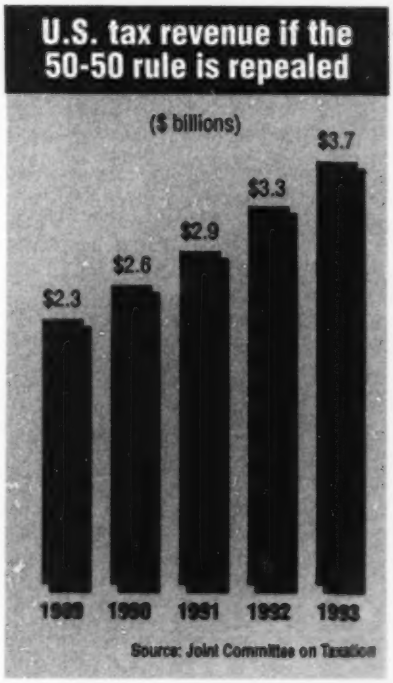
The export source issue, as it is called, is highly technical and riddled with exacting "legalese." It centers on how much Uncle Sam is entitled to collect on income earned from foreign sources through the sale of American-made goods — when title of those goods is transferred to an overseas buyer *outside* the United States. At the heart of the debate are two intertwined issues: territoriality and an ill-defined term called "independent factory price," which the IRS is claiming should be applied more often to these types of sales.

If the title of the goods sold is transferred to an overseas buyer *inside* the United States, then revenue from that sale is now considered U.S.-sourced income, and the current IRS regulations on exports do not apply. But, if the transfer of goods takes place outside of the United States, then the IRS claims it can assess an independent factory price for those goods sold. Once that independent factory price is set, the IRS can then dun the U.S. factory for the majority of the tax bill.

For both the tax man and corporate America, the stakes are high. While the IRS wants to boost taxes, corporations argue that exports will suffer as a result. By radically changing the rule, the IRS could increase taxes by over $2 billion a year, according to the congressional Joint Committee on Taxation. Such a change means annual exports would drop between $3.6 billion and $5.3 billion, counters the Export Source Coalition (ESC). The ESC, a Washington, D.C.-based lobbying group, wants to maintain the status quo on the export source rule. Almost half of its 41 member companies are electronics firms and three out of 11 trade groups are from the electronics industry.

Guinea pigs

The disproportionate concern by the high-tech community is no coincidence. Two prominent Silicon Valley companies, Intel Corp. and Hewlett-Packard Co., are being used by the IRS as guinea pigs in its challenge of the export source rule. In its audits of both companies, the Internal Revenue Service argues that the widely accepted interpretation of the export source rule has been inappropriately applied. As a result, both companies face possible higher tax burdens and lengthy legal battles should they decide to fight the Treasury's definition of independent factory price when it is made public.



An added concern voiced by William Pearlman, a vice president at Intel, is that no American company has set up a reserve to cover the additional tax expense should the IRS get its way. "It could be significantly negative for all companies," Pearlman warns. The IRS could legally apply the rule retroactively, charging companies for all tax years still open to federal scrutiny. For some companies, that means digging back 20 years into internal tax records.

Tax experts caution, however, that high tech has not been singled out for special scrutiny. Intel and HP are in the spotlight, they say, simply because they happen to be inside the IRS' western regional jurisdiction. And, unfortunately for both companies, the international tax experts in the IRS San Francisco office have been the prime movers in this issue and insist their auditors pursue it as far as they can. This suggests that West Coast electronics companies are more likely to feel the long arm of the IRS than their counterparts in other regions of the United States. The western region includes Alaska, California, Hawaii, Idaho, Nevada, Oregon and Washington.

The 50-50 rule

Meanwhile, the Treasury Department is trying to resolve the issue as diplomatically as possible. It has to balance the zeal of the IRS against the economic consequences of stifling exports. While it went part way to pacify corporations by agreeing in late August that the old interpretation — the so-called "50-50 rule" — will continue to be the predominant interpretation, it has yet to define the meaning of an "independent factory price." Treasury called for definitions from concerned corporations to be submitted by mid-September and was expected to come out with its own definition by early October. By press time, however, no definitive ruling had been handed down.

Depending on how the independent factory price is defined will determine how extensively companies can apply the old interpretation of the rule. One interpretation of the independent factory price distributes taxable income between United States and foreign sources based on contri-

bution to value added. If the independent factory price is not applicable, then companies will still be allowed to use the 50-50 rule, whereby 50% of the income on the sale can be classified as foreign-sourced income, and the remaining 50% as U.S. income.

Although it is tough to generalize, corporate tax accountants say that most companies prefer using the 50-50 formula method for two reasons: it is more straightforward; and it usually means lower taxes. If they are forced to apply the independent factory price, companies worry that the change could effectively lower the 50-50 rule to something closer to 10-90.

While the IRS refuses to comment on its audits, sources expect Hewlett-Packard could be the first to test the legality of the issue. According to Lester Ezrati, HP's tax counsel, the company will have three options: before paying anything, it could either take the case to the IRS appeals branch or go directly to tax court; alternatively, it could first pay the tax then take the case to the U.S. district court and try to overturn the ruling. Ezrati says that since the issue is so technical, HP would be better off going directly to tax court.

BRUCE C.P. RAYNER

How the new tax code works

Let's say that America Inc. sells $1,000 worth of chips to Deutschland AG and makes $100 taxable income on the sale. The goods are manufactured by and shipped from America Inc.'s San Jose facility directly to Deutschland's Munich headquarters. As a result of this, title is transferred to Deutschland in Munich.

Also assume that America Inc. has a branch in XYZ country that also manufactures and sells chips. The branch makes $100 of taxable income on sales of which it pays $50 in taxes to the government of XYZ country. The branch sends the remaining $50 profit back to the home office of America Inc. in San Jose in the form of a remittance of profits. The branch does not pay XYZ country any withholding tax.

The U.S. tax rate is 34%, so the U.S. tax on the total $200 income would be $68 before any adjustments are made.

A. Assume that America Inc. is allowed to use 50-50 export source rule, meaning that 50% of the $100 income from the Deutschland AG sale is considered foreign and 50% is considered domestic. So, of the $200 of total income, $150 of it is considered foreign source taxable income. The calculation of the foreign tax credit limitation (FTCL) used to offset U.S. taxes is as follows:

$$\frac{\text{Taxable foreign source income}}{\text{Total taxable income}} = \frac{\$50+\$100}{\$200} = 75\% \times \$68 = \$51 \text{ of U.S. tax}$$

The applicable FTCL is the lower of the foreign taxes paid ($50) or the above calculation ($51). It is the foreign taxes of $50. America pays the IRS only $18 ($68 minus $50). Under the 50-50 rule, America's total worldwide taxes are $18 plus $50, or $68.

B. Assume that America Inc. has to apply the independent factory price to its income on the Deutschland AG sale. So, 90% of the $100 income is derived from the U.S. factory and 10% is considered foreign-source income. The calculation of the FTCL used to offset U.S. taxes would be:

$$\frac{\text{Taxable foreign source income}}{\text{Total taxable income}} = \frac{\$10+\$100}{\$200} = 55\% \times \$68 = \$37.50$$

The applicable FTCL would then be only $37.40 (the lower of the FTCL or total foreign taxes paid). So America Inc. would pay the IRS $30.60 ($68 minus $37.40). Total worldwide taxes are $30.60 plus $50, or $80.60 □

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Telephone: 301/280-1122

Brazil could be the world's fifth-largest electronics market by the year 2000. But obstacles to doing business there are many — as American vendors are finding

Blame it on Rio

Brazil's tough stance on imports

BY VALERIE RICE

With a rapidly growing population of 160 million people and a land mass bigger than all of Europe, Brazil is poised to be one of the major economic forces of the next century. But an economy crippled by runaway inflation, incredible poverty, and internal political struggles jeopardizes that future. So the country's hopes are pinned on the bright spot in Brazil: an electronics industry, which many believe to be the fastest growing in the world today.

But the Brazilian Informatics industry, as they call their electronics sector, is at a turning point. Politicians have made decisions which could forever hinder Brazil's goal to be a major electronics player, and businessmen, frustrated by missed opportunities and an oppressive government, are demanding reform. Meanwhile, one of the tastiest market opportunities in years seems to be slipping out of reach.

The world electronics market would like a piece of the action in Brazil, and American companies are no exception. Americans are evaluating the market possibilities, but, like the rest of the world, are puzzled by the market dynamics. They're also put off by widespread allegations of Brazil's intellectual property piracy, and by the restrictions imposed by the nation's notorious Informatics Law. Opportunities do exist for U.S. firms, but only patience, creativity and luck can ensure entrance into the market.

The Brazilian electronics industry last year was an almost $2 billion market (roughly one-fifth the size of Texas' electronics market) and is growing at more than 30% per year, according to U.S. Department of Commerce and other figures. It already manufactures huge volumes of TVs, VCRs and appliances, not to mention a giant auto industry that is a voracious consumer of chips from suppliers such as Motorola Inc. The American Electronics Association predicts that Brazil could be the fifth-largest electronics market in the world by the year 2000.

But that growth has come at the expense of a free market, as the Brazilians slammed their doors shut in 1984 to give indigenous companies a chance to grow their own. This policy of "market reserve" — reserving the market for themselves in terms codified in the Informatics law — restricts the import of any product containing digital computing power, as well as software and technical services.

Items not included under this law are, for example, mainframe computers, printed circuit boards and anything to do with telecommunications. Also restricted are technology exchanges or joint ventures, as well as equity participation by a foreign company if it owns the technology. The Informatics law is an eight-year law, set to end in 1992. What may replace it, if anything, is unknown.

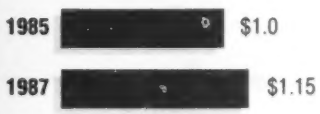
Brazil took this step because "we are different than any other nation," de-

Claus Meyer/Black Star

The Brazilian electronics market

Hardware

Includes peripherals, PCs to mainframes and ATMs ($ billions)

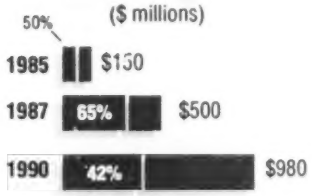


These figures represent mostly indigenous Brazilian industry, with the exception of the mainframe sector, which is almost entirely supplied by multinationals (IBM) or imports. ATMs make up a significant percentage.

Source: ELECTRONIC BUSINESS estimates

Semiconductors

($ millions)



Of the $190 million in locally made chips in 1987, about $60 million is from U.S. companies; $55 million from Siemens/Philips; about $40 million from other European companies and Japanese suppliers; and only $35 million from native Brazilian companies.

Sources: ELECTRONIC BUSINESS estimates, Sid Micro

Software

Includes PC to mainframe software ($ millions)

The personal computer software portion of these numbers does not include the value of pirated software, which could account for as much as 50% of the market.

Source: ELECTRONIC BUSINESS estimates

when the Informatics law ends, these three companies must show demonstrable ability in running a 2-micron CMOS fab. Right now, CMOS technology does not really exist in Brazil outside of research facilities.

Protection needed

Of all the industries in Brazil, the fledgling semiconductor industry is the most at risk if the doors of the country are opened. Victor Blatt, managing director of Sid Microeletronia SA, acknowledges that "without the Informatics law, we wouldn't be able to exist. We would be competing with multinationals. We need this protection to continue for a few more years."

This protection has allowed Sid to be profitable. And, since the company grew at a rate of 20% last year, it expects to reach $40 million in revenue at the end of 1988.

What the Brazilians want to go after, according to Blatt and others, is "90% of what's produced that isn't memory or microprocessors." One area in which Blatt feels Sid is making strides is ASICs. Thanks to the market reserve, Sid can take the time to get an ASICs group up and running, and can afford to hire the very best from the universities. Using Mentor Graphics Corp. equipment, Sid has started an ASIC subsidiary, Verte Sid Sistemas Integrados (VSI), that is currently tackling the Brazilian market with a staff of 30."We can be more than competitive in this," he claims, "because our cost of engineering is lower and we have very good people."

Itautec is also striving after the ASICs market, and company *diretor comercial/industrial* Gabriel Antonio Marao claims that he has put in design centers in Brazil, and has done 25 different designs to date. Itautec, which is owned by the major Brazilian merchant bank Itau, is involved with two consortiums in Brazil which are trying to start a chip set industry. The 14-member consortium has already developed a PC AT chip set which was delivered in production quantities last month, and hopes to do an Intel 80386 chip set as well. □

A price comparison

U.S. versus Brazil on PC XT and Apple IIe (in U.S. dollars)

PC XT

	U.S.	Brazil
CPU	$1,350	$3,300
Monitor	400	1,500
Hard drive	300	4,500
Total system	$2,050	$9,300

Apple IIe

	U.S.	Brazil
CPU	$280	$300
Monitor	80	300
Drive	75	285
Disk interface	90	66
Total system	$525	$988

Source: Exame Informatica

Breaking into Brazil: A business primer

A word of warning for Americans considering Brazil as a market: it's not for the faint of heart or short of term.

First there's the question of timing. Current market reserve policy is due to end in 1992, which could mean that the country will then be more open to foreign investment. So companies in business before then could have a distinct advantage over the newcomers. But the main issue is, of course, how to get products into a restricted country. American companies can sell pretty much directly into Brazil in areas not covered by the Informatics law. Those include telecommunications, printed circuit boards, and any mainframe technology.

There are other areas, covered by Informatics, but difficult for the Brazilian market to provide, that Americans could have access to. Brazil's computer industry association indicates that products in these sectors may be welcome: CAD/CAM software and systems, CRTs, terminals, semiconductor production and test equipment, power supplies and high-end engineering terminals. And Brazil's lack of CMOS fabs makes semiconductors one of the most obvious opportunities.

But American companies wanting to get into Brazil must play the game. Finding a Brazilian distributor or sales representative can be difficult. The president of one small components company who recently spent two weeks in Brazil has given up because his telexes never get answered. And once a representative is found, agreements must be made, and then

SEI must review the paperwork and make a decision.

The best business in Brazil is conducted over a cup of coffee. Not just any coffee, but a *capezhino*, a strong, sweet cup of coffee served in a demitasse cup. But drinking the offered coffee with a smile is just the start when doing business in Brazil. Consider the following:

- Americans doing business in Brazil have to constantly think about money. For example, although the minimum wage is $50 per month, employees get a "raise" every month — the percentage is set by the government — to offset inflation. And contracts, ironclad in the United

States, are often renegotiated every month to allow for current pricing.

- Negotiate contracts in dollars, rather than the local currency of *cruzados*. A good recruiting tool in Brazil is to offer to pay an executive in dollars.
- With ever-changing laws and policies, it is best to have a Brazilian law firm on retainer. Intellectual property protection is a prime consideration in Brazil, and having access to a Brazilian law firm can help minimize the risks.
- Portuguese is the official language, and any petitions to the government or bureaucratic bodies must be done in Portuguese. Hiring a translator — or a native — is a must.
- Be prepared for red tape. It can take 18 months or longer to get a license to import a product, so there is no fast turnaround or just-in-time policy making in Brazil. □

The Brazilian black market: Do you know the way to Paraguay?

In downtown Sao Paulo there is a street, the "electronics alley," where rumor has it that a customer can get anything — anything — he wants. Table after table of parts, from components to transistors to alligator clips, cover the street, and only the proprietors know what is on the back shelves of the stores.

But shopping on Avenida Santa Effegia is not for those who don't speak Portuguese.

This is the black market, *the mercado paralelo*, where items not available legally in Brazil, or at the right price, can be found — if one knows the right people.

Smuggling in Brazil is not isolated to one street in Sao Paulo. Instead, it seems that a large number of small- and medium-sized businesses regularly smuggle small amounts of product just to stay alive. Larger companies, too, often turn to smuggling to augment supplies or cut costs.

Contraband

In addition, estimates indicate that 50% of the personal computers in Brazil were smuggled in, and up to 40% of the software is either smuggled or pirated. And some sources also say the amount of smuggling is growing.

In fact, the amount of electronic merchandise smuggled into Brazil last year exceeds legal shipments of United States products to the country, by almost one-third. At the same time, United States electronics shipments to Brazil last year were worth about $230 million, while contraband into Brazil last year was estimated at over $300 million, according to the U.S. Department of Commerce.

The semiconductor figure alone could be even larger. The Brazilian government suggests that over $600 million worth of contraband components are in Brazil at any time.

Motorola Inc.'s Robert Salatka, director of international marketing, says he can't account for the large installed base of his products in Brazil; the company just doesn't sell that much product there.

"There are very good indications that contraband is alive and well and occurring with some frequency," Salatka says. "Brazil stops imports toward the end of the year when the balance of trade is not favorable for them."

A source close to the U.S. government and an expert on Brazil notes that "contraband is a tremendous business in Brazil. What occurs between Brazil and Paraguay is not a secret, and it's not just electronics. It's gold for agricultural products and autos for other things. If someone needs something fast, the black market is the way to go."

All of this is because products legally imported to Brazil go through nine tariffs and and one brokerage tax, the end result of which can be as much as 150% on top of the original price of the product.

Reasons to smuggle

The high tariffs are one reason that large companies often smuggle. Although most computer companies have import permits for products they require, they are rumored to import minimal amounts of product, and to smuggle the rest, in order to amortize the high cost of the legality across a number of products.

Although large companies contacted in Brazil deny involvement with the black market, one vendor suggests that even the government is involved.

One reason smuggling is so prevalent is Brazil's close proximity to Paraguay, where legality seems more flexible than in many places.

Potential smugglers can rent a warehouse in Paraguay; establish a phony business; rent a truck; and use one of the five overland routes or transport the smuggled cargo by a water route from Paraguay into Bra-

Smuggled goods such as electronics and automobiles often come down from Miami to Paraguay. From there the goods travel overland by different routes into Brazil, a nation hungry for foreign products

zil; all without blinking an eye.

Before the product gets to Paraguay, it travels by plane from Miami, where a host of small distributors cater to the Latin American market, with or without legal intent. Many of these are small "garage" operations, and most operate on referrals. None contacted would speak with the press. Another big source is Miami's ComputerLand store, where traveling Brazilian businessmen often stop before coming home.

Electronics smuggling has taken on a more sinister feel lately, say involved Brazilian locals, because drugs have entered the scene. Drug smugglers, operating out of South America, want a load to bring back from the United States and what better than in-demand electronics?

"Drug smugglers love electronics items," says one Brazilian computer industry official. □

Staying one step ahead of the pirates in Brazil

Cloning United States high-technology products is big business in Brazil, and clones, from software look-alikes to personal computers, are flourishing, thanks to the high import duties on legal products.

But for an American company finding non-licensed clones of its products, getting legal recourse may tend to be a very difficult task. If a copyright, trademark or patent is not registered in the country of Brazil, its owner cannot go to court in Brazil to seek damages or an injunction against the infringer. And often times foreign companies choose not to register in Brazil, because if the registered patent, for example, is not used within a two year period, it essentially becomes public property.

Yet, Brazil should be on its best behavior these days, thanks to the threat of U.S. trade sanctions. Although the sanctions have currently been suspended, they could be reinvoked at any time if Uncle Sam decides that Brazil is not acting fairly with regard to market access or intellectual property protection.

So if there's evidence that an American product, logo or trademark is being copied, the time to act is now. One expert source of information on this subject is Apple Computer Inc.'s director of government affairs, James Johnson. Johnson is an attorney who spearheaded Apple's successful push to squash upstart Macintosh clone maker Unitron Eletronia without going to court.

Four-step program

In a four-step program, he suggests approaching the United States Trade Representative's office and the International Trade Administration office with the evidence. Johnson stresses that a government protest carries a lot of weight, and says companies should highlight the connection to the U.S. government's national trade case against Brazil.

Next, the infringed company should send a "cease and desist" letter to the offending Brazilian company. Then the Special Secretariat for Informatics (SEI) should be alerted to the situation. "This is a violation of Brazilian law," Johnson states. "Even if we can't go to court, it is against the law." Johnson also suggests that U.S. companies retain a Brazilian lawyer.

The final step, and one that was successful for Apple, is tipping off the local press. Johnson claims that the press in Brazil is sympathetic to the U.S. viewpoint, and "that kind of exposure can be very effective." □

Manaus: Free trade zone in the Amazon

The Amazon region in Brazil is hardly a place anyone would expect business to flourish. That portion of the country is illiterate, agrarian and consists primarily of favellahs, or slums, according to the U.S. council for commercial affairs in Brazil, Arthur Trezise.

Yet the severely depressed northeast region of the country is getting a shot in the arm, thanks to the free trade zone center established in Manaus, the only major city at the foot of the Amazon. Travelling American businessmen liken it to any American industrial zone, the only jarring note being the proximity of the river and the jungle.

In this free trade zone, companies can import or export parts without restriction, and the bulk of the products are exported. Because of the cheap wages ($50 per month), Manaus is mainly a giant assembly operation, with almost 400 companies operating there, according to the council for commercial affairs.

But companies operating in the Informatics arena are excluded from participation in Manaus, and electronics industry officials claim the

success of the free trade zone comes at the expense of their industry.

In this very closed market, Manaus represents a low-cost way in, at least to cheap manufacturing. The bulk of the foreign companies doing business in Manaus export their products, and executives argue that Brazil is no better off with this export mentality. Executives also complain that the Informatics industry in Brazil is short on capital and incentives, and they're more than happy to blame Manaus.

"One of the reasons Brazilian industry is not as competitive is because of Manaus," says ABICOMP (Brazilian Computer Industry Association) board member Ricardo Saur. "Manaus is entirely incentive driven and it's artificial."

The existence of Manaus, established during Brazil's almost 30 years of military rule, also runs counter to the Brazilian philosophy of owning its own technology. In Manaus, most of the technology is foreign-owned, and consumer electronics companies, a large percentage of Brazilian companies operating in Manaus, are unable to be competitive in the world export market because of this, executives argue.

"Most critics sarcastically refer to Manaus as the import processing zone, rather than the export processing zone," Saur says. □

American companies in Brazil: Doing business the hard way

How do American companies do business in a country with such restrictive markets?

Carefully, and with patience, says Fairchild Semiconductoras Ltda. *gerente geral*, or general manager, Hank Mahler. Fairchild, which has been making diodes and transistors in Brazil for 15 years, has learned how to "go with the flow," according to Mahler.

Fairchild is not alone. There are almost 400 American companies doing business in Brazil, although most are not in high tech. Those, like Fairchild, IBM, Motorola Inc., NCR Corp., Unisys Corp. and others, that are in the market reserve area, have been grandfathered in under the new law, and allowed to continue operations.

According to Mahler, things haven't been so bad there. "In the long term, business is good here," he says. "That's something that a lot of American businesses have difficulty accepting."

The hardest things to adjust to, according to Mahler, have been the rapid economic and political changes that tend to obscure the long-term direction the country is taking.

Another challenge is the lack of local infrastructure, which makes planning for the future difficult, Mahler says. Multinationals in Brazil must give SEI a plan at the beginning of every year that outlines import needs quarter by quarter. That plan, if SEI approves it, is pretty much set in stone, Mahler says, and "forces you to be right most of the time."

Ironically, Fairchild and presumably the other American companies have benefitted from market reserve, despite the increase in red tape. "The same benefits a local company gets from market reserve we also get. We have been very successful in gaining market share," he says.

But for American companies not established in Brazil, the going can be rough. Computer and terminals maker Wyse Technology has evaluated Brazil and the market reserve policy, and decided instead to invest in Venezuela, says international sales manager Mark Kvamme.

"In the past 12 months, South America has been a strategic market development area for us," Kvamme says. "Brazil is the largest market, but it has the largest local content rules and the greatest number of hoops to go through. It is just not attractive to do business there right now."

Another company that does not find expanded investment attractive is Texas Instruments Inc. Although TI has been doing business there for 25 years, it announced last year that it would be willing to make a "substantial investment in Brazil if there is a reason to do so."

For TI, the bait is tempting. Brazil represents a huge market for consumer goods, automobiles, telecommunications products and ultimately computers, much of which remains untapped.

But TI would want to enter on its own terms, the same terms it uses worldwide: a 100% owned subsidiary, which is positively verboten under Informatics law for a foreign company. Even equity participation isn't allowed currently. Talks continue with the Brazilian government, but TI doesn't seem optimistic. "We are still in the stage of getting the government to allow us in," says a spokesman. □

Randall Hyman/Stock Boston

clares Brazilian Computer Industry Association (ABICOMP) board member Ricardo Saur. "You cannot compare us. Other nations are export oriented. We are not — we want to satisfy our own needs. We can't do that without protection."

CIA running high tech?

Overseeing this legislation is the Special Secretariat for Informatics, or SEI, which has been known to strike fear in the hearts of even the most honest high-tech company. Word is that SEI, set up under the military regime, is akin to the U.S. National Security Council. Brazilians note that having SEI oversee the electronics market is a lot like having the CIA running high-tech legislation in the United States.

Be that as it may, SEI is virtually the final word on everything electronic, from imports to exports, as well as which products can be produced in Brazil, and which must be brought in from the outside. Foreign companies must get approval from SEI to export to Brazil (no mean feat), while indigenous companies must get approvals on foreign supplies and equipment. SEI is nominally overseen by CONIN, a national council on Informatics, but that body is generally seen as impotent when compared with SEI.

SEI tends to make its import decisions based on whether or not the technology already exists in Brazil. If it does, or can be made to exist, a foreign company is out of luck. If it doesn't exist, there are certainly opportunities.

"This is a very complicated country," says one senior Brazilian electronics executive who declined to be named. "There is too much government intervention and it is a directed economy. It is difficult to do business here."

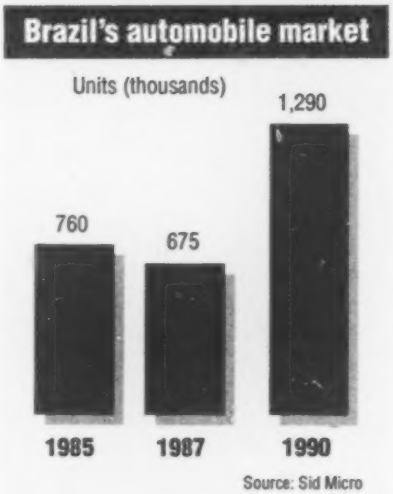
The difficulties all begin and end with the government, according to one American executive who is trying to set up a joint venture in Brazil. "Being in Brazil makes our government look easy to work with," he says.

Unlike the United States, merchant banks are legal and very powerful in Brazil, and they all have a hand in the Informatics industry. Itau is one of the largest banks in Brazil, as well as one of the biggest Informatics players. The same is true for Citicorp/Elebra. So if the Brazilians have a market development model, it is very much like that of Japan.

"Brazil is trying to emulate the Japanese development models," says U.S. Department of Commerce's Brazil expert Robert L. Farris. "This is planned development. There is a lot of government and industry cooperation, and the market targets are very specific. This is not a shotgun approach to business."

Since the Informatics law was established in 1984, the Brazilian electronics industry has been hampered by the nation's economic recession. Inflation is averaging 18% per month, and industries like computers and automotive have not grown significantly over the past few years. The relatively stagnant computer industry has not hurt the Brazilians as much as expected. It is a much smaller portion of the overall electronics market than in other countries. Yet there are growth segments in Brazil; unlike the United States, the consumer industry is very strong, as are telecommunications and military sectors.

Robert Fried/Stock Boston



Brazil's giant auto industry is a voracious consumer of chips from suppliers such as Motorola

Nothing is easy

For American companies considering doing business in Brazil, it is necessary to understand the dynamics. Change is the order of the day; after all, Brazil has rewritten its constitution nine times in the past 100 years.

Under the market reserve system, Brazil shut its doors before it had an infrastructure established to support its electronics industries, and it lacks the expertise — and capital — to develop its own. Brazilian executives acknowledge this with disgust, noting that although they have incentives through tax breaks to use Brazilian-made goods, the products are —more often than not — unavailable, or at best, sole-sourced.

Importing the necessary parts, be it components, silicon wafers, gold lead wiring, solder, etc., brings with it an unbelievable set of tariffs, which can add between 30% and 105% to the cost of the goods. The answer for many companies has been a spot of judicious smuggling (see related story).

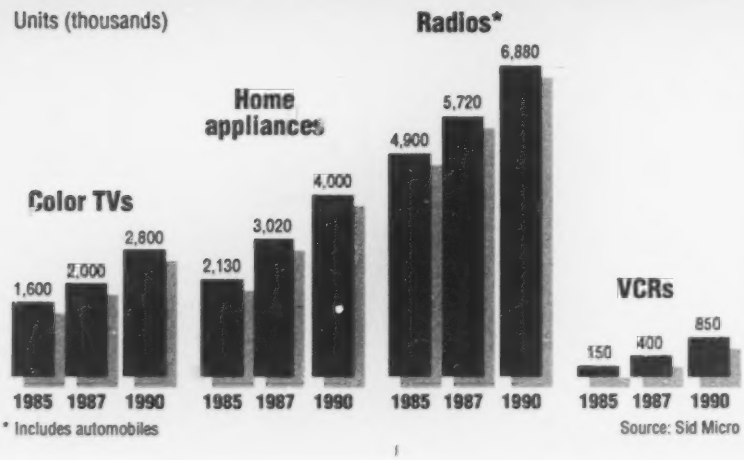
Another challenge to the Brazilian Informatics industry has been the flourishing growth in the free-trade zone in Manaus, a northeast region that has successfully attracted foreign business. Industry in Manaus has grown at an astonishing rate, but the Informatics portion of Brazil's domestic industry is barred from participating in this export-only zone.

According to one Brazilian semiconductor executive, all of the country's problems can be traced to a lack of capital. Indeed, his explanation of the Informatics law reveals that no one in Brazil could afford to invest in high technology without the law, and the government, needing technology for national security reasons, was forced to close the doors.

One area Brazil has succeeded in

Owen Franken/Stock Boston

Major Brazilian consumer electronics markets



nurturing has been the personal computer market, certainly the largest segment of the indigenous computer market. But even the PC business isn't easy, since Brazilian companies have difficulty competing with (smuggled) American computers, which are cheaper and often more efficient.

Right now, there are over 100 companies in Brazil trying to get a share of the PC software and hardware market; most of it is IBM-compatible, although there is some cloning of Apple Computer Inc. products. Right now, state-of-the-art technology is a Motorola 68020 microprocessor, with the largest installed base; followed by the Intel Corp. 80286 and the ever-popular 8086. Up and coming are, of course, the 68030 and the 80386, but there is little evidence of RISC chips entering the country as yet. The Brazilian portion of the data-processing market stops at the superminicomputer level; IBM, which has been in Brazil since 1914, has virtually 100% of the mainframe market — allowed because mainframes are not part of the Informatics law.

Because volume is low, economies of scale don't really exist in Brazil, and working conditions are often far from a "clean room" atmosphere, and can have an impact on the quality of products.

Government-owned computer manufacturer Cobra Computadores e Sistemas Brasilieiros SA is a good example. Cobra is one of the largest PC manufacturers in Brazil, and also makes products up to the superminicomputer level. But the company has upward of 20% absenteeism per month, and manufactures, in a good month, only 1,000 computers with its 1,000 employees.

Hiring complaints

And, because it is government owned, it cannot pay competitive salaries, so executives complain about not being able to hire good software and hardware engineers.

That is just the beginning of Cobra's problems. Cobra does very little manufacturing itself; it is more of an assembly house, and imports most of its parts from the United States. But under the market reserve system, it is difficult and expensive — really expensive — to import chips and other parts, so the system costs skyrocket. It can take upward of 18 months to get an import permit in Brazil, and then it can be restrictive as to quantity and type.

Given all these self-made obstacles, it is difficult to believe that anyone in the country would support market reserve. Many Brazilian businessmen don't; others, however, like ABICOMP, make compelling arguments in favor of keeping the doors closed until the law ends in 1992. Says board member Saur: "Unless specific measures were taken temporarily, Brazilian industry would have no chance to compete on the worldwide market."

Joint ventures, often a way low-technology countries can get up to speed quickly, are seen as inappropriate for Brazil, Saur says, because "they bring in technology and access, but they don't bring in technology at the level the Brazilian people wanted."

One small pocket of market reserve supporters can be found in the semiconductor industry in Brazil. SEI licensed three semiconductor vendors under the Informatics law: Elebra, Itautec and Sid Microeletronica, and they are the heart and soul of the industry.

The term "manufacturer" should be used loosely in Brazil. Two of these three companies do not have fabs, and the third, Sid Micro, has a very old linear/discrete fab which produces, in actual fact, very few parts. These companies are essentially resellers or distributors of U.S., Japanese or European chips in Brazil.

The problem with the lack of front-end fabs in Brazil is that by 1992,

Well! Look who paid no '87 taxes to Uncle Sam!

IBM, AMD, Xerox and others actually got rebates from the IRS in 1987. But possible tax hikes and more complex rules spell headaches for high tech

BY BRUCE C.P. RAYNER and LINDA STALLMANN

They must have great tax attorneys. Last year, big wheels in the U.S. electronics industry — companies like Data General Corp., IBM and Zenith Electronics Corp. — not only paid no federal tax, but many received tax credits.

Part of the reason is that U.S. electronics firms are more reliant on foreign operations than ever before; for example, in 1987, almost all of IBM's tax provision went to governments overseas. In part, too, the rebates are thanks to deferred investment tax credits. But with the repeal of the investment tax relief laws, that's a situation that may not be repeated.

Indeed, increased tax-law complexities and the threat of budget-balancer tax increases from a new White House administration do not bode well for high tech. On average, electronics-industry taxes were already higher in 1987 than in the previous year.

The dust has yet to settle on the Tax Reform Act of 1986. With a technical corrections bill being hammered out in Congress and the Internal Revenue Service trying to interpret the bill, corporate America is doing its best to get a handle on what is going on. It is not an easy task.

According to the ELECTRONIC BUSINESS annual survey of the top electronics industry taxpayers for 1987, the figures are superficially encouraging (see chart). For the 130 companies on the list, the average effective tax rate dropped from 42.9% in 1986 to 39.4% in 1987. For the top 20 companies, all but six posted a decline in their effective tax rates between 1986 and 1987. Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics qualified for inclusion on this list.

Not surprisingly, IBM was again the top electronics taxpayer, accounting for 39% of total 1987 tax provisions of the companies listed. In fact, IBM set more aside for taxes in 1987 than the next top 12 companies combined — but not a cent of that money is going to Uncle Sam. The Feds wound up *giving* Big Blue a credit of $113 million on its U.S. earnings of nearly $4 billion based on deferred investment tax credits of $141 million. Among the other 23 companies that came off clean with Uncle Sam were seventh-ranked Xerox Corp. and 37th-placed Perkin-Elmer Corp.

On the surface, the electronics industry has survived tax reform with minimal damage. True, the investment tax credit is no longer around, nor is the capital gains differential. But a watered down version of the research and experimentation (R&E) tax credit, a big perk for high tech, looks to be a shoo-in for a two-year extension. It is up to the congressional Joint Committee on Taxation to work out the details, but most high-tech Hill watchers are confident the R&E credit will survive.

However, taking a closer look behind glossy annual reports and industry aggregates reveals an unsettling picture of the aftermath of reform. For example, if IBM is taken off the ELECTRONIC BUSINESS top taxpayers list, the remaining 129 companies ended up by posting an *increase* in their average effective tax rate last year, from 35.7% in 1986 to 39.6% in 1987. Again, excluding IBM, the total tax burden increased by 67.8% between 1986 and 1987, while net income rose by 63%.

Rebates all around...

Federal tax credit for fiscal 1987 ($ millions)

IBM	$113.00
Perkin-Elmer	25.79
Teradyne	11.50
Zenith	11.00
Data General	9.11
Decision Industries	6.29
Xerox	6.00
Cipher Data	3.49
Esterline	3.31
Andrew	2.48
Micropolis	1.35
Sun Electric	1.22
BRIntec	0.81
Coherent	0.38
Applied Materials	0.31
Cherry Electrical	0.25
AMD	0.09

Sources: ELECTRONIC BUSINESS and company reports

Too complex

Besides higher rates and more taxes, electronics companies insist the new law has added considerably to the administrative burden of doing business. "If you talk to the typical company chiefs, they will say that the complexity due to the transition is what strikes them the most, not that they are paying more or less in taxes as a corporation," comments James LeMunyon, a lobbyist for the American Electronics Association (AEA) in Washington, D.C.

Even the accountants are concerned. Reform has complicated their work to the point where they cannot function without a computer. The biggest culprits, they say, are the alternative minimum tax (AMT) and the new uniform capitalization rules. "You have to raise the question of whether or not our tax system has gone a little bit haywire if the only way you can get your tax compliance

Jean Francois Allaux

done is by buying a computer program," comments Kent Schreiner, a principal in the Boston office of Ernst & Whinney, a Big Eight accounting firm.

Some high-tech tax experts warn that tax reform goes further than just higher bookkeeping costs. They complain that start-up activity is being hampered by the restrictions on net operating loss (NOL) carryforwards and a higher capital gains tax. Also, defense contractors are being squeezed as a result of the repeal of the completed contracts method of accounting, which used to allow a contractor to defer taxes. Without it, productivity, research and development and capital investment will drop significantly, defense industry leaders say. "It is like taxing a farmer as soon as he plants his crop," complains Don Fuqua, president of the Aerospace Industries Association. The drought in the defense business does not help either.

Tax reform is making itself felt on the international front too. Reform has lowered the U.S. tax rate below that of most trading partners, thus making international tax planning more critical for American companies that operate overseas. Because of the new rules, the complexity of international tax planning has also increased significantly. As a result, Big Eight accountants are recommending their clients reevaluate all their offshore operations.

Nowhere is this more evident than in electronics. For the ELECTRONIC BUSINESS top taxpayers, over 60% of 1987's taxes went to foreign governments, reflecting a significant reliance on offshore manufacturing and international markets. In the case of top taxpayer IBM, the foreign tax burden is even more pronounced. In 1987, 99.6% of IBM's tax provision went to foreign governments, even though only 54% of its products were sold overseas. This resulted in an effective foreign tax rate of 58.7% last year for Big Blue.

Despite the rhetoric from Washington about rebuilding America's international competitive position, tax reform has made it more difficult for U.S.-based high-tech companies to export, claims Mark Singer, a tax partner at the accounting firm of Price Waterhouse in San Jose. "I think it is almost a policy question that at a time when we are concerned with our balance of trade with other countries, some of the changes have discouraged exports from an economic standpoint," he says.

How to stifle foreign business

In particular, Singer points to limitations on foreign tax credits as an example of how tax reform is stifling foreign business. Also, various changes in the tax laws, such as the "super royalty," mean that operations in low-tax countries such as Ireland or Switzerland have become less attractive. In essence, the super royalty charges a license fee on technology transferred offshore based on the market value of the product that is being maufactured, a rate higher than companies previously had to pay.

"Super royalty is most likely bad tax policy," says Howard Slayen, a tax partner-in-charge at the San Jose/Menlo Park office of Coopers & Lybrand, a Big Eight accounting firm. Slayen complains that in its zeal to close a loophole, "Congress went too far in coming up with a system that is not rational and not in conformity with accepted international standards."

In an unrelated foreign tax issue, the Internal Revenue Service is changing its interpretation of how a company can pass title across international borders. Based on its interpretation of section 863(b) of the tax code, the IRS used to let companies transfer title outside the United States and use the foreign source income toward a tax credit on U.S. taxes. But now, the IRS is making it harder to claim that credit.

Given such a climate, most tax experts suggest close scrutiny of foreign operations as the first step toward more effective tax planning. However, because of the November election and the expected tax changes in 1989, the planning horizon should be kept short — no more than two or three years, the pencil pushers say.

Another possibility, says Ernst & Whinney's Schreiner, is for electronics companies to change the capitalization ratios in their foreign subsidi-

aries. A higher debt burden, he says, could be a way to save money. For instance, instead of issuing shares in the foreign company, make a loan from the U.S. parent. In this way, the subsidiary can take a tax deduction while the U.S. parent company pays a relatively lower tax rate in-country on the interest income it earns.

Back on the domestic front, a new Financial Accounting Standards Board (FASB) statement No. 96 is changing the way all corporations have to report their income taxes. The new rule is mandated to take effect on Dec. 15 of this year. Initially, FASB 96 had the support of the accounting community, but because of its complexity, many tax accountants have changed their opinion.

"There will be many high-tech companies whose earnings will be adversely affected by FASB 96, which, as a result, will be reporting higher income expense and lower earnings to the public," says Singer at Price Waterhouse. The lower earnings might prompt some companies to change their corporate planning strategies, he speculates.

In essence, the 100-page FASB statement forces corporations to report their deferred taxes to take into account any current or subsequent changes in tax rates. The reason is so that the balance sheet better reflects the true liability of taxes due, says an FASB spokesperson. But many accountants contend that the new ruling will create wild swings in the tax expense and on the bottom line. And with tax rates changing every few years, the fluctuations in the financial reports could distort the public's perception of the health of the company. According to Ernst & Whinney's Schreiner, FASB 96 will also affect how foreign taxes are reported, thus creating even more of a whiplash effect in company figures.

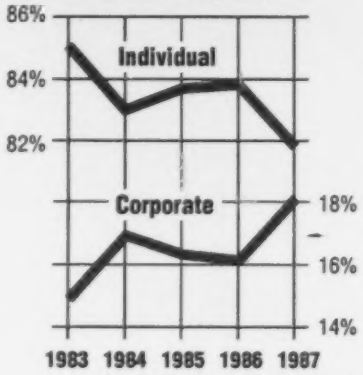
The next surprise

The whiplash will most likely be compounded. Corporate America's next surprise will be what the new president will do to reform the reform. Watch for the National Economic Committee's report, due out early next year, to set the stage for tax policy changes. Pundits expect the report will condone tax increases — possibly corporate rate increases — as one way to get a handle on the 1990 federal budget deficit.

The bottom line on tax reform

Corporations have been footing more of the tax bill...

Percentage of income and profit taxes collected by the IRS



Source: IRS

...and tax reform isn't helping

Estimated additional tax revenue paid by U.S. corporations as a result of the Tax Reform Act of 1986 ($ billions)

Sources: Department of Treasury, Office of Tax Analysis

But for now, the best that tax planners can do is guess at what the tax laws will be like next year. Besides some vague generalities, neither presidential candidate is committing to concrete fiscal strategy. Vice President George Bush has said he would reinstate the 15% capital gains tax, but little else has been heard from either candidate.

Adding to the political uncertainty is the future chairmanship of the powerful Senate Finance Committee that is currently held by Texas senator and Democratic vice-presidential hopeful Lloyd Bentsen. If Massachusetts Gov. Michael Dukakis wins the presidential election, the chair will probably go to ranking Democrat Spark Matsunaga of Hawaii.

Whoever gets elected, the critical task ahead will be how to handle the federal budget deficit. Economists agree it will involve both raising taxes and lowering spending. David Wyss, chief financial economist at Data Resources Inc., expects some increase in "sin taxes" on tobacco and alcohol, but does not see much chance for a proposed value-added tax or even any significant change in the corporate tax rate. However, if Congress finds itself in dire need, "the corporate rate is one they are likely to come after," he says. Wyss also speculates on a drop in the capital gains tax to around 20%, down from its current 28% level, coupled with a leveling off of the top personal tax rates to around 32%.

It is still too early to have hard and fast numbers on the economic effects of tax reform. Even when the figures become available, it will be difficult to isolate those changes caused by tax reform. But one of the critical gauges that economists are watching is the rate of capital investment. Some doomsayers claim that tax reform has crippled manufacturing investment, while others point to healthy investment growth in early 1988 as proof that investment decisions are being made more on economic grounds than on the basis of favorable tax breaks. The reality is probably a combination of the two.

A study conducted by Gordon Richards, an economist at the National Association of Manufacturers in Washington D.C., estimates that $30 billion in gross national product growth has been wiped out by tax reform. The main reason for the drop was the one time increase in the cost of capital as a result of the repeal of the investment tax credit, he says.

But for the electronics industry, there have been mitigating circumstances that have helped to dampen the negative effects of tax reform, says Richards. The fall in the value of the U.S. dollar has spurred U.S. sales of computers and data-processing equipment, while the steady drop in prices of electronic equipment has offset the repeal of the ITC. For the present then, high tech should count itself lucky. □

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) ($ millions) 1987	1986	Percentage change from 1986	1987 income tax provision (benefit) ($ millions) Federal	State and local	Foreign
1	IBM	$3,351.0	$3,600.0	-6.9%	($113.0)	$128.0	$3,336.0
2	DEC	551.5	240.1	129.7%	297.1	48.7	205.8
3	GM Hughes Electronics	378.1	366.1	3.3%	319.3	62.3	(3.5)
4	Unisys	369.5	(48.4)	NM	186.6	24.1	158.8
5	NCR	343.1	283.2	21.2%	95.4	10.4	237.4
6	Hewlett-Packard	318.0	264.0	20.5%	82.0	37.0	199.0
7	Xerox	262.0	112.0	133.9%	(6.0)	6.0	262.0
8	Tandy	213.6	186.4	14.6%	193.5	17.7	2.4
9	Apple Computer	192.9	155.8	23.8%	146.2	27.9	18.9
10	AMP	180.8	129.7	39.4%	57.1	19.1	104.6
11	Honeywell	158.2	26.9	488.1%	79.0	14.7	64.5
12	Texas Instruments	157.8	59.0	167.5%	101.0	NA	57.0
13	Amdahl	125.0	29.5	323.7%	92.9	17.1	15.0
14	Intel	112.3	8.7	1,198.8%	67.3	14.9	30.1
15	Litton Industries	110.8	56.9	94.8%	86.5	15.3	9.1
16	Motorola	108.0	71.0	52.1%	65.0	17.0	26.0
17	Pitney Bowes	95.7	93.3	2.5%	51.3	13.7	30.7
18	Compaq Computer	92.7	31.9	190.6%	72.0	3.3	17.4
19	Cray Research	85.3	100.4	-15.0%	70.0	10.1	5.3
20	Tandem Computers	79.3	50.7	56.4%	45.0	12.4	21.9
21	Tektronix	51.9	3.0	1,628.3%	12.9	2.4	36.6
22	Microsoft	49.5	26.7	85.0%	NA	NA	NA
23	Seagate Technology	46.0	1.6	2,782.1%	35.6	10.4	0.0
24	Intergraph	45.9	53.1	-13.6%	32.4	3.4	10.1
25	General Instrument	41.7	11.2	272.3%	26.9	4.5	10.2
26	Loral	41.3	41.3	0.0%	37.0	4.3	0.0
27	Harris	37.9	1.1	3,323.3%	28.3	6.7	2.9
28	E-Systems	35.8	47.8	-25.1%	35.8	NA	NA
29	Medtronic	34.9	34.9	0.0%	17.9	4.6	12.4
30	Ashton-Tate	33.9	28.1	20.8%	21.5	6.7	5.7
31	Sun Microsystems	32.8	9.0	263.9%	17.4	5.8	9.7
32	Control Data	32.5	10.0	225.0%	7.4	3.5	21.6
33	Molex	32.0	21.3	50.3%	1.8	0.8	29.4
34	Lotus Development	30.9	22.7	35.8%	21.7	1.7	7.5
35	Atari	30.7	22.2	38.3%	25.4	0.1	5.1
36	Computer Associates	30.6	14.7	107.8%	18.2	2.5	9.9
37	Perkin-Elmer	24.8	39.7	-37.4%	(25.8)	1.4	49.3
38	Scientific-Atlanta	24.3	(6.4)	NM	20.9	1.2	2.2
39	Avnet	23.8	18.4	29.3%	20.0	3.9	0.0
40	Gould	23.2	22.5	3.1%	5.6	1.1	16.5
41	Cullinet Software	22.4	11.1	101.2%	21.6	0.7	0.1
42	Prime Computer	21.6	15.6	38.0%	14.1	1.3	6.2
43	National Semiconductor	19.5	14.5	34.9%	18.2	2.2	(0.9)
44	Diebold	19.4	21.8	-11.1%	16.8	2.6	—[1]
45	Wang Laboratories	19.0	5.0	280.0%	0.3	0.5	18.2

[1] Foreign and federal taxes reported together

NM = Not meaningful
NA = Not available

Effective tax rate		Fiscal 1987 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
38.9%	42.9%	54,217.0	8,609.0	5,258.0	54.0%	12/87	1	Armonk, N.Y.
32.7%	28.0%	9,389.4	1,689.0	1,137.4	47.0%	6/87	4	Maynard, Mass.
42.0%	45.1%	10,481.0	899.2	521.1	11.6%	12/87	3	Detroit, Mich.
39.0%	-52.7%	9,712.9	947.5	578.0	43.6%	12/87	5	Detroit, Mich.
45.0%	45.7%	5,640.7	762.4	419.3	54.6%	12/87	11	Dayton, Ohio
33.1%	33.8%	8,090.0	962.0	644.0	49.0%	10/87	8	Palo Alto, Calif.
31.2%	16.6%	10,320.0	840.0	578.0	44.9%	12/87	7	Stamford, Conn.
46.6%	48.2%	3,452.2	458.8	242.3	1.6%	6/87	17	Ft. Worth, Texas
47.0%	50.3%	2,661.1	410.4	217.5	27.1%	9/87	22	Cupertino, Calif.
42.0%	44.1%	2,317.8	430.5	249.7	52.3%	12/87	34	Harrisburg, Pa.
38.4%	67.6%	6,679.3	411.9	253.7	20.6%	12/87	10	Minneapolis, Minn.
38.1%	59.8%	5,594.5	414.7	256.9	31.5%	12/87	12	Dallas, Texas
46.8%	42.9%	1,505.2	267.0	142.0	44.3%	12/87	41	Sunnyvale, Calif.
39.0%	5.0%	1,907.1	287.9	175.5	38.8%	12/87	35	Santa Clara, Calif.
44.5%	44.4%	4,419.7	249.0	138.1	22.7%	7/87	20	Beverly Hills, Calif.
26.0%	26.8%	6,707.0	416.0	308.0	43.8%	12/87	9	Schaumburg, Ill.
41.9%	46.3%	2,250.5	228.7	199.4	19.5%	12/87	31	Stamford, Conn.
40.7%	41.7%	1,224.1	228.1	136.3	26.0%	12/87	47	Houston, Texas
36.7%	44.6%	687.3	232.4	147.1	37.0%	12/87	68	Minneapolis, Minn.
42.9%	44.3%	1,035.5	184.9	105.6	44.4%	9/87	52	Cupertino, Calif.
50.3%	7.1%	1,395.9	103.0	51.2	42.2%	5/87	44	Beaverton, Ore.
40.8%	40.5%	345.9	121.3	71.9	42.3%	6/87	86	Redmond, Wash.
24.8%	4.4%	958.1	185.7	139.7	43.6%	6/87	53	Scotts Valley, Calif.
39.6%	43.0%	641.1	115.8	69.9	36.9%	12/87	71	Huntsville, Ala.
38.6%	37.7%	787.9	107.9	18.5	16.2%	2/88	50	New York, N.Y.
41.8%	41.8%	690.0	98.7	57.5	6.2%	3/87	61	New York, N.Y.
31.0%	1.8%	2,079.0	122.4	84.5	14.7%	6/87	30	Melbourne, Fla.
37.2%	43.7%	1,227.2	96.2	60.4	6.6%	12/87	54	Dallas, Texas
32.1%	32.1%	502.0	108.7	73.8	41.5%	4/87	79	Minneapolis, Minn.
44.0%	48.2%	267.3	77.0	43.1	30.3%	1/88	129	Torrance, Calif.
47.5%	43.0%	537.5	69.1	36.3	32.0%	6/87	65	Mountain View, Calif.
56.6%	3.6%	3,366.5	57.4	25.0	20.0%	12/87	26	Minneapolis, Minn.
42.2%	39.7%	386.8	75.8	43.4	68.4%	6/87	90	Lisle, Ill.
30.0%	32.0%	395.6	102.9	72.0	52.3%	12/87	94	Cambridge, Mass.
41.0%	47.0%	493.2	74.8	44.2	45.9%	12/87	82	Sunnyvale, Calif.
45.6%	44.3%	309.3	67.1	36.5	48.7%	3/87	74	Garden City, N.Y.
372.6%	35.4%	1,333.6	6.7	-18.2	46.2%	7/87	46	Norwalk, Conn.
50.0%	-41.0%	495.3	48.5	24.3	15.0%	6/87	81	Atlanta, Ga.
51.1%	43.6%	1,547.1	46.6	22.8	0.0%	6/87	42	New York, N.Y.
48.1%	39.4%	933.4	48.2	25.0	38.0%	12/87	60	Rolling Meadows, Ill.
44.7%	46.0%	174.9	-50.0	-27.6	26.4%	4/87	153	Westwood, Mass.
25.0%	25.0%	960.9	86.4	64.8	48.0%	12/87	58	Natick, Mass.
209.7%	10.8%	1,867.9	-9.3	-28.8	42.1%	5/87	36	Santa Clara, Calif.
35.1%	38.4%	439.1	55.1	35.8	7.0%	12/87	101	Canton, Ohio
36.8%	8.9%	2,836.7	-51.7	70.7	40.1%	6/87	21	Lowell, Mass.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) ($ millions) 1987	1986	Percentage change from 1986	1987 income tax provision (benefit) ($ millions) Federal	State and local	Foreign
46	Dynatech	$18.5	$18.5	0.0%	$13.1	$2.0	$3.4
47	Digital Communications	17.6	14.0	25.9%	15.6	2.0	0.0
48	Western Digital	14.7	7.2	104.4%	6.8	4.0	4.0
49	Maxtor	14.6	14.6	0.0%	10.6	3.7	0.3
50	MAI Basic Four	14.6	11.3	29.1%	4.5	1.3	8.7
51	Gerber Scientific	13.3	13.3	0.0%	11.2	1.5	0.6
52	Xidex	12.8	20.2	-36.6%	10.2	2.3	0.4
53	Apollo Computer	12.7	6.0	113.8%	4.2	1.9	6.7
54	Oracle Systems	12.3	4.6	168.1%	9.1	2.2	0.9
55	Ultimate	12.2	12.2	0.0%	9.4	1.8	1.0
56	Stratus Computer	12.2	10.0	22.4%	8.1	2.2	1.9
57	Bolt Beranek and Newman	11.9	8.4	41.4%	10.9	1.1	NA
58	Mentor Graphics	11.4	5.5	105.9%	5.0	0.5	6.0
59	Wyse Technology	11.3	7.9	43.5%	9.1	2.1	0.2
60	Watkins-Johnson	11.0	12.7	-14.1%	10.9	0.0	0.0
61	Measurex	10.7	9.8	9.5%	4.6	0.9	5.2
62	Mark IV Industries	10.7	8.4	27.5%	9.6	—[2]	1.1
63	Varian Associates	10.5	(25.3)	NM	3.5	1.3	5.7
64	AVX	10.5	(1.3)	NM	8.9	0.9	0.6
65	ADC Telecommunications	10.2	9.0	13.2%	9.2	1.0	0.0
66	Emerson Radio	9.4	9.4	0.0%	5.2	0.7	3.6
67	Micropolis	9.1	14.1	-35.8%	(1.3)	3.0	7.5
68	AST Research	8.7	22.1	-60.7%	4.7	1.5	2.4
69	Genicom	8.6	7.4	16.7%	5.2	1.0	2.4
70	Avantek	8.3	13.3	-37.3%	6.8	1.5	0.0
71	Veeco Instruments	7.9	0.2	3,282.0%	1.1	(0.3)	7.1
72	Recognition Equipment	7.5	6.0	24.8%	2.1	—[2]	5.4
73	LSI Logic	7.0	4.1	70.8%	2.3	1.3	3.4
74	Augat	7.0	(3.8)	NM	2.9	0.9	3.2
75	Analog Devices	6.9	8.7	-20.2%	0.2	0.4	6.3
76	Inmac	6.9	4.4	55.4%	3.8	0.8	2.3
77	Dynascan	6.6	6.0	10.6%	6.6	0.0	0.0
78	Altos Computer	6.1	11.2	-45.5%	4.2	1.4	0.6
79	Logicon	6.1	6.1	0.0%	5.1	1.0	0.0
80	ISC Systems	6.0	9.9	-39.1%	5.3	0.8	NA
81	Marshall Industries	5.9	11.0	-46.8%	4.8	1.1	0.0
82	Storage Technology	5.6	17.7	-68.4%	2.7	(0.1)	3.0
83	Compugraphic	5.4	1.8	196.2%	NA	NA	NA
84	Cubic	5.2	(0.3)	NM	4.1	1.1	0.0
85	MiniScribe	5.1	2.8	82.1%	3.0	0.9	1.2
86	Wyle Laboratories	4.7	2.7	75.6%	3.8	0.9	0.0
87	Datapoint	4.2	8.0	-47.5%	1.3	0.0	2.9
88	Fluke	4.2	4.8	-12.4%	3.6	NA	0.5
89	Anthem Electronics	4.1	2.9	40.8%	3.3	0.8	0.0
90	Coherent	4.1	3.4	19.8%	(0.4)	0.3	4.2

[2] State taxes included with federal

NM = Not meaningful
NA = Not available

Effective tax rate		Fiscal 1987 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
44.3%	44.3%	$304.7	$41.7	$23.2	25.4%	3/87	102	Burlington, Mass.
39.4%	40.4%	181.4	44.6	27.0	19.0%	6/87	160	Alpharetta, Ga.
25.6%	26.0%	462.5	57.5	42.8	36.9%	6/87	76	Irvine, Calif.
39.4%	39.4%	175.3	36.9	22.4	16.0%	3/87	142	San Jose, Calif.
38.9%	40.0%	321.0	37.4	22.8	64.1%	9/87	106	Tustin, Calif.
38.9%	38.9%	223.9	34.2	21.1	47.0%	4/87	138	Hartford, Conn.
33.5%	38.5%	572.8	38.2	-44.5	29.9%	6/87	85	Sunnyvale, Calif.
37.0%	39.0%	553.7	34.4	21.7	51.8%	12/87	78	Chelmsford, Mass.
44.0%	43.7%	131.3	27.9	15.6	46.8%	5/87	172	Belmont, Calif.
47.0%	47.0%	172.9	26.0	13.8	23.4%	4/87	159	East Hanover, N.J.
38.7%	42.5%	184.2	31.6	19.4	29.2%	12/87	174	Marlboro, Mass.
305.2%	42.7%	233.8	3.9	-8.0	0.0%	6/87	122	Cambridge, Mass.
36.0%	33.5%	221.8	31.7	20.3	45.9%	12/87	151	Beaverton, Ore.
38.5%	38.6%	260.0	29.5	18.1	20.2%	3/87	95	San Jose, Calif.
38.1%	42.5%	264.3	28.7	17.1	19.0%	12/87	133	Palo Alto, Calif.
28.6%	31.7%	227.4	37.5	26.8	59.4%	11/87	149	Cupertino, Calif.
38.6%	45.1%	403.0	27.8	17.0	14.6%	2/88	113	Amherst, N.Y.
33.0%	-63.0%	982.8	31.9	21.4	23.6%	9/87	56	Palo Alto, Calif.
39.9%	-29.2%	271.9	26.3	15.8	43.0%	12/87	123	Great Neck, N.Y.
40.0%	42.9%	166.9	25.4	15.3	12.4%	10/87	178	Minneapolis, Minn.
26.2%	26.2%	810.1	36.1	26.6	0.0%	3/87	63	Secaucus, N.J.
25.0%	43.7%	288.3	36.3	27.2	69.7%	12/87	121	Chatsworth, Calif.
40.0%	44.9%	206.0	21.7	13.0	19.6%	6/87	119	Irvine, Calif.
45.1%	46.2%	302.2	19.2	12.6	32.0%	12/87	116	Waynesboro, Va.
41.8%	45.2%	213.7	19.9	11.6	13.0%	12/87	152	Santa Clara, Calif.
41.9%	13.0%	195.6	18.8	9.2	46.1%	9/87	156	Melville, N.Y.
40.0%	40.0%	264.7	18.7	11.2	49.1%	10/87	126	Irving, Texas
40.7%	48.2%	262.1	17.3	10.7	[illegible]%	12/87	134	Milpitas, Calif.
37.9%	-30.3%	313.2	18.4	11.5	[illegible]%	12/87	111	Mansfield, Mass.
27.0%	27.0%	370.4	25.6	18.7	46.4%	10/87	97	Norwood, Mass.
47.0%	46.8%	165.4	14.6	7.7	59.2%	7/87	181	Santa Clara, Calif.
54.4%	49.5%	191.6	12.1	6.6	2.1%	12/87	168	Chicago, Ill.
38.8%	35.7%	153.9	15.8	9.7	42.0%	6/87	188	San Jose, Calif.
50.2%	50.2%	204.8	12.2	6.1	0.0%	3/87	155	Torrance, Calif.
48.0%	41.7%	168.5	12.6	6.5	0.0%	6/87	176	Spokane, Wash.
51.3%	51.2%	286.6	11.4	5.1	0.0%	5/87	105	El Monte, Calif.
22.8%	51.3%	750.0	24.6	19.0	26.4%	12/87	66	Louisville, Colo.
34.8%	35.0%	367.1	15.5	10.1	28.9%	12/87		Wilmington, Mass.
39.8%	-33.5%	361.8	13.2	7.9	0.0%	9/87	114	San Diego, Calif.
15.2%	12.1%	362.5	33.2	28.1	36.1%	12/87	99	Longmont, Colo.
45.0%	38.5%	368.0	10.5	5.8	0.0%	1/88	132	El Segundo, Calif.
7.7%	NM	312.1	-54.3	-58.5	79.2%	7/87	110	San Antonio, Texas
67.5%	28.1%	206.3	6.2	2.0	40.5%	9/87	157	Everett, Wash.
45.2%	52.0%	196.9	9.1	5.0	0.0%	12/87	162	San Jose, Calif.
136.9%	NM	159.0	3.0	-1.1	46.4%	9/87	185	Palo Alto, Calif.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) ($ millions) 1987	1986	Percentage change from 1986	1987 income tax provision (benefit) ($ millions) Federal	State and local	Foreign
91	Singer	$4.0	$6.8	-41.2%	$1.3	$0.0	$2.7
92	SCI Systems	4.0	8.5	-52.9%	NA	NA	NA
93	CTS	3.9	3.5	14.1%	2.4	0.6	1.0
94	Applied Magnetics	3.9	0.8	415.3%	2.0	1.1	0.8
95	Aydin	3.8	5.2	-27.7%	3.0	0.8	0.0
96	Micom Systems	3.7	3.7	0.0%	1.0	1.7	1.1
97	Intelligent Systems	3.7	1.5	151.0%	3.0	0.7	0.0
98	TIE/communications	3.6	3.1	16.2%	2.7	0.7	0.2
99	Westmark International	3.4	(10.9)	NM	2.5	0.7	0.3
100	Pioneer-Standard	3.4	1.3	162.1%	2.8	0.6	0.0
101	DSC Communications	3.1	2.4	27.9%	0.2	2.6	0.3
102	Cherry Electrical	3.0	(1.5)	NM	(0.3)	—[2]	3.3
103	Tandon	2.8	2.3	19.1%	2.2	—[2]	0.5
104	Sprague Technologies	2.7	1.8	50.0%	0.5	0.2	2.0
105	Computer Consoles	2.6	2.0	29.2%	0.2	2.3	0.1
106	BRIntec	2.5	6.8	-63.3%	(0.8)	0.2	3.2
107	Advanced Micro Devices	2.5	(9.1)	NM	(0.1)	1.6	1.0
108	Dataproducts	2.1	2.1	0.0%	0.1	0.7	1.3
109	Quantum	2.1	9.6	-78.4%	0.7	1.4	0.0
110	Paradyne	1.7	0.8	98.0%	0.0	0.4	1.3
111	Diasonics	1.6	1.3	26.2%	0.2	0.1	1.3
112	VLSI Technology	1.3	0.3	389.6%	0.2	1.0	0.1
113	General DataComm	1.3	(2.4)	NM	0.2	0.3	0.8
114	Andrew	1.2	6.8	-82.5%	(2.5)	0.6	3.1
115	GenRad	1.1	0.8	43.8%	0.0	0.1	1.0
116	Oak Industries	0.8	2.7	-70.6%	0.1	0.1	0.6
117	LTX	0.7	(6.2)	NM	0.0	0.0	0.7
118	International Rectifier	0.6	0.7	-9.8%	0.0	0.5	0.1
119	Kollmorgen	0.6	(2.7)	NM	0.0	0.0	0.6
120	Sun Electric	0.5	2.3	-78.2%	(1.2)	0.0	1.7
121	Savin	0.3	0.0	NM	NA	NA	NA
122	Applied Materials	0.2	0.9	-73.1%	(0.3)	0.3	0.2
123	Arrow Electronics	0.0	0.0	0.0%	0.0	0.0	0.0
124	Esterline	(2.6)	1.4	NM	(3.3)	0.6	0.1
125	Cipher Data Products	(3.5)	3.4	NM	(3.5)	0.2	0.9
126	Data General	(4.0)	4.9	NM	(9.1)	(1.0)	6.1
127	Decision Industries	(6.0)	3.4	NM	(6.3)	0.2	0.1
128	Zenith Electronics	(9.8)	(10.2)	NM	(11.0)	(1.1)	2.3
129	Teradyne	(11.7)	(2.9)	NM	(11.5)	(0.3)	0.1
130	M/A-COM	(19.6)	(16.5)	NM	NA	NA	NA
	Total	**$8,541.2**	**$6,694.3**	**27.6%**	**$2,649.9**	**$641.1**	**$5,192.3**

[2] State taxes included with federal

NM = Not meaningful
NA = Not available

Effective tax rate		Fiscal 1987 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
14.6%	10.4%	$1,902.7	$27.4	$23.4	0.0%	12/87	40	Stamford, Conn.
20.0%	38.1%	552.9	20.0	16.0	24.8%	6/87	73	Huntsville, Ala.
27.3%	14.9%	261.1	14.4	10.5	19.7%	12/87	135	Elkhart, Ind.
21.6%	15.6%	211.9	18.1	14.2	46.5%	9/87	144	Goleta, Calif.
30.0%	42.8%	149.2	12.6	8.8	17.8%	12/87	199	Horsham, Pa.
23.3%	23.3%	196.7	15.9	12.2	10.0%	3/87	154	Simi Valley, Calif.
23.6%	61.8%	163.2	15.5	10.2	26.6%	12/87	189	Norcross, Ga.
48.4%	5.6%	250.2	-7.4	-11.1	30.3%	12/87	125	Shelton, Conn.
89.9%	-39.8%	291.9	-3.8	-7.2	28.0%	12/87	118	Seattle, Wash.
39.2%	40.9%	212.2	8.6	1.8	0.0%	3/88	143	Cleveland, Ohio
17.3%	17.8%	312.4	17.6	14.6	14.4%	12/87	112	Plano, Texas
52.6%	-38.8%	160.6	5.8	2.7	49.4%	2/87	190	Waukegan, Ill.
13.9%	3.8%	289.1	19.8	17.1	75.0%	12/87	120	Chatsworth, Calif.
42.9%	1.1%	437.3	6.3	3.6	38.2%	12/87	89	Greenwich, Conn.
21.3%	84.9%	148.4	12.2	9.6	21.4%	12/87	200	Waltham, Mass.
29.8%	36.8%	293.7	8.4	5.9	15.8%	12/87	150	Willimantic, Conn.
5.6%	8.8%	997.1	-45.1	-48.1	27.2%	12/87	57	Sunnyvale, Calif.
19.0%	19.0%	338.8	11.1	9.0	26.8%	3/87	107	Woodland Hills, Calif.
19.0%	30.1%	120.8	10.9	8.8	21.0%	3/87	177	Milpitas, Calif.
176.0%	2.2%	232.6	-0.9	-2.6	17.9%	12/87	146	Largo, Fla.
9.7%	8.0%	267.6	16.9	15.2	3.1%	12/87	127	South San Francisco, Calif.
14.0%	82.7%	172.0	9.4	8.1	22.1%	12/87	184	San Jose, Calif.
62.5%	NM	200.6	2.1	0.8	21.9%	9/87	166	Middlebury, Conn.
23.9%	41.8%	223.2	5.0	3.8	40.7%	9/87	147	Orlando Park, Ill.
34.7%	2.6%	193.8	3.2	2.1	40.4%	12/87	165	Concord, Mass.
12.3%	9.8%	182.2	6.5	5.7	14.4%	12/87	182	Rancho Bernardo, Calif.
11.8%	-32.9%	120.6	-6.0	-6.7	51.0%	7/87	198	Westwood, Mass.
3.6%	60.6%	151.8	-16.6	-17.2	50.1%	6/87	197	Los Angeles, Calif.
67.1%	-11.8%	301.0	0.9	0.3	11.4%	12/87	136	Hartford, Conn.
5.4%	62.4%	203.9	-9.2	3.3	30.0%	10/87	175	Crystal Lake, Ill.
72.8%	0.0%	356.3	0.4	0.1	10.8%	12/87	130	Stamford, Conn.
41.9%	42.0%	174.4	0.6	0.3	43.9%	10/87	158	Santa Clara, Calif.
0.0%	0.0%	562.4	-15.8	-15.8	0.0%	12/87	77	Farmingdale, N.Y.
-8.2%	59.9%	259.7	-31.9	-29.3	39.1%	10/87	167	Darien, Conn.
NM	31.9%	178.2	0.2	4.3	18.4%	6/87	183	San Diego, Calif.
-5.8%	35.0%	1,274.3	-69.9	-82.9	45.0%	9/87	45	Westboro, Mass.
-22.7%	30.7%	191.4	-26.4	-20.4	5.5%	11/87	169	Horsham, Pa.
33.9%	-50.5%	2,362.7	-28.9	-19.1	17.2%	12/87	29	Glenview, Ill.
-35.3%	NM	377.7	-33.2	-21.5	36.4%	12/87	98	Boston, Mass.
-40.1%	-42.6%	436.1	-48.9	-29.3	21.5%	9/87	88	Burlington, Mass.
39.4%	—	**$202,336.8**	**$21,693.1**	**$13,276.5**				
Weighted average								

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

Capital spending: The boom will end, but '89 is no bust

Capital equipment vendors should enjoy 1988 while they can -- 1989 forecasts call for a slower spending pace. Big-ticket buys could continue

BY LINDA STALLMANN AND DAVID CARD

Forecasters expect electronics companies to slow their capital spending pace in 1989.

That's the bad news. The good news is that the comparison is relative to 1988, which will close out as a capital equipment boomlet.

The top 100 U.S. electronics companies spent $14.3 billion on capital equipment last year, up 3.9% from what those same companies spent in 1986. (Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics are compared.) This year's growth will be even greater, as projections for some specific industry sectors suggest.

According to a survey by Lexington, Massachusetts-based Data Resources Inc., companies making electrical and electronic components will increase their spending this year by 42.7% compared with last year. The research firm shows spending by communication equipment companies up 13.6% in 1988, and office equipment makers up 25.8%.

But watch out for 1989, cautions DRI economist Nigel Gault. Preliminary budgeting plans at component companies call for only a 19% increase in 1989. And communication and office equipment suppliers will cut spending by 10% and 11.3%, respectively.

Gault points out that there is a "built-in tendency to underestimate spending plans," so 1989 probably will not be as bad as the early budgets indicate. Capital equipment vendors, Gault says, "shouldn't be planning on an increase like 1988, but at the moment, it looks like 1989 will be a reasonably good year."

Caution on 1989 is the watchword with other forecasters too. If she were an equipment supplier, Elizabeth Baatz of Cahners Economics says, "I wouldn't be terrified, but I'd be keeping my eye open" looking toward 1989. Cahners Economics is pretty negative on the general economy, expecting a 1989 gross national product growth of only 1.1%.

Rebound in 1990

Cahners Economics forecasts manufacturing spending across all industries to increase 10.7% in 1988, but expects it to shrink 0.9% the next year. 1990 will rebound, with spending growing 5.2%. "Things people can order in smaller quantities will drop off sooner," Baatz says of 1989, indicating that spending on expensive items — automatic test equipment, for example — may hold up longer, but drop off in early 1990.

Last year, semiconductor companies spent the most on capital equipment as a percentage of sales. Custom chip makers LSI Logic Corp. and VLSI Technology Inc. spent 67% and 29%, respectively.

However, the spree is over for now, says LSI Logic chief financial officer D. Scott Mercer. This year, he has cut spending by 66%, down to around $60 million, anticipating pick-up to the $80 million to $100 million range in 1989.

So is Chrysler Corp.'s electronics assembly subsidiary: it bought some testers this year and is looking to add more. Computer-aided design and manufacturing equipment and surface-mount assembly equipment are also on plant manager Roger Rickey's shopping list. He expects to spend $40 million to $50 million over the next three or four years.

But are America's computer companies spending enough? Not according to Arthur D. Little Inc. analyst Jerry Wasserman. He evaluates a company's capital spending by comparing it with its net cash flow — the ratio of equipment spending to profits plus depreciation after dividends. Wasserman likes to see a 100% to 130% ratio, but in 1987, most of the big computer companies, for example, were nowhere near that ratio.

Wasserman speculates that they were watching the bottom line too closely. To compete against Japanese companies with their access to cheaper capital, managers in the United States must look further ahead, Wasserman insists. "We have got to have CEOs willing to stand up in front of the financial community and in front of their boards of directors," he says. "Unless they make the long-term investments, their companies are going to be buried." □

Top capital spenders

1987 rank	Company	Total capital expenditures ($ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
1	IBM	$4,304.0	-6.8%	7.9%	70.2%	$54,217.0	12/87
2	Xerox	937.0	-9.2%	9.1%	97.3%	10,320.0	12/87
3	DEC	748.4	32.6%	8.0%	47.6%	9,389.4	6/87
4	Unisys	720.9	30.3%	7.4%	75.4%	9,712.9	12/87
5	Motorola	658.0	11.0%	9.8%	91.5%	6,707.0	12/87
6	Hewlett-Packard	507.0	1.6%	6.3%	54.8%	8,090.0	10/87
7	GM Hughes Electronics	469.4	-33.0%	4.5%	56.1%	10,481.0	12/87
8	Texas Instruments	462.8	3.8%	8.3%	82.0%	5,594.5	12/87
9	NCR	389.2	7.9%	6.9%	62.4%	5,640.7	12/87
10	Honeywell	304.2	8.1%	4.6%	53.0%	6,679.3	12/87
11	Intel	301.5	94.8%	15.8%	86.9%	1,907.1	12/87
12	Pitney Bowes	251.8	20.6%	11.2%	88.9%	2,250.5	12/87
13	Litton Industries	242.8	-17.4%	5.5%	84.7%	4,419.7	7/87
14	Storage Technology	179.2	454.8%	23.9%	183.5%	750.0	12/87
15	Control Data	178.3	13.8%	5.3%	73.8%	3,366.5	12/87
16	LSI Logic	174.5	147.5%	66.6%	339.5%	262.1	12/87
17	AMP	171.8	13.3%	7.4%	57.6%	2,317.8	12/87
18	Amdahl	157.8	37.8%	10.5%	66.2%	1,505.2	12/87
19	Data General	142.9	10.1%	11.2%	576.1%	1,274.3	9/87
20	Tandem Computers	142.4	119.0%	13.7%	90.3%	1,035.5	9/87
21	Advanced Micro Devices	137.9	0.8%	13.8%	141.8%	997.1	12/87
22	Wang Laboratories	128.0	-45.2%	4.5%	42.8%	2,836.7	6/87
23	Compaq Computer	113.3	124.4%	9.3%	71.4%	1,224.1	12/87
24	Prime Computer	100.5	10.9%	10.5%	69.0%	960.9	12/87
25	National Semiconductor	94.7	-19.0%	5.1%	79.2%	1,867.9	5/87
26	Tandy	93.1	69.2%	2.7%	34.3%	3,452.2	6/87
27	Apple Computer	86.1	29.3%	3.2%	31.6%	2,661.1	9/87
28	Harris	83.6	-28.3%	4.0%	39.7%	2,079.0	6/87
29	Singer	78.7	-13.1%	4.1%	109.5%	1,902.7	12/87
30	Seagate Technology	78.4	102.7%	8.2%	46.8%	958.1	6/87
31	Sun Microsystems	76.1	110.2%	14.2%	124.0%	537.5	6/87
32	Perkin-Elmer	66.5	-2.9%	5.0%	492.2%	1,333.6	7/87
33	General Instrument	63.2	-13.8%	8.0%	103.7%	787.9	2/87
34	Microsoft	58.0	311.2%	16.8%	73.0%	345.9	6/87
35	Zenith Electronics	55.4	-9.2%	2.3%	247.3%	2,362.7	12/87
36	Apollo Computer	53.7	29.3%	9.7%	84.3%	553.7	12/87
37	E-Systems	51.1	7.0%	4.2%	68.3%	1,227.2	12/87
38	MiniScribe	50.5	139.5%	13.9%	128.2%	362.5	12/87
39	VLSI Technology	50.1	79.3%	29.1%	152.1%	172.0	12/87
40	Molex	49.5	23.3%	12.8%	65.2%	386.8	6/87
41	Gould	49.0	-14.3%	5.2%	51.2%	933.4	12/87
42	Avnet	47.3	109.7%	3.1%	146.5%	1,547.1	6/87
43	Varian Associates	46.2	-7.7%	4.7%	87.3%	982.8	9/87
44	Intergraph	43.7	-44.3%	6.8%	44.8%	641.1	12/87
45	Analog Devices	43.0	17.2%	11.6%	82.1%	370.4	10/87
46	Teradyne	41.0	34.9%	10.8%	374.1%	377.7	12/87
47	Tektronix	40.7	-40.5%	2.9%	30.2%	1,395.9	5/87
48	Western Digital	40.6	149.8%	8.8%	66.7%	462.5	6/87
49	Cray Research	40.2	-66.3%	5.8%	18.3%	687.3	12/87
50	Loral	34.2	-26.0%	5.0%	45.9%	690.0	3/87

Source: ELECTRONIC BUSINESS

(Continued)

Top capital spenders

1987 rank	Company	Total capital expenditures ($ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
51	AVX	$31.8	187.4%	11.7%	91.9%	$271.9	12/87
52	SCI Systems	29.6	172.1%	5.4%	104.8%	552.9	6/87
53	Augat	29.4	22.5%	9.4%	136.0%	313.2	12/87
54	Altos Computer	28.9	1,039.8%	18.8%	199.8%	153.9	6/87
55	Medtronic	28.4	469.6%	5.7%	32.3%	502.0	4/87
56	M/A-COM	26.7	-72.7%	6.1%	-295.1%	436.1	9/87
57	Lotus Development	26.6	71.1%	6.7%	30.3%	395.6	12/87
58	Applied Magnetics	25.7	148.4%	12.1%	98.8%	211.9	9/87
59	Datapoint	25.6	-2.8%	8.2%	-74.1%	312.1	7/87
60	Avantek	24.4	21.5%	11.4%	97.7%	213.7	12/87
61	Sprague Technologies	24.3	-38.2%	5.6%	76.2%	437.3	12/87
62	DSC Communications	23.2	21.5%	7.4%	53.5%	312.4	12/87
63	Micropolis	22.3	38.6%	7.7%	62.0%	288.3	12/87
64	Bolt Beranek and Newman	22.2	27.8%	9.5%	489.1%	233.8	6/87
65	Recognition Equipment	21.7	79.9%	8.2%	96.6%	264.7	10/87
66	Compugraphic	19.7	34.8%	5.4%	NA	367.1	12/87
67	Digital Communications	19.0	127.9%	10.5%	57.4%	181.4	6/87
68	Maxtor	17.4	125.8%	9.9%	66.1%	175.3	3/87
69	Cubic	17.1	98.6%	4.7%	118.8%	361.8	9/87
70	Oracle Systems	16.9	47.3%	12.9%	80.6%	131.3	5/87
71	Cherry Electrical	15.4	68.6%	9.6%	114.5%	160.6	2/87
72	General DataComm	15.3	-4.4%	7.6%	134.9%	200.6	9/87
73	Mentor Graphics	14.7	44.1%	6.6%	43.2%	221.8	12/87
74	Stratus Computer	13.8	-11.6%	7.5%	49.6%	184.2	12/87
75	LTX	13.6	156.0%	11.3%	283.6%	120.6	7/87
76	Kollmorgen	13.5	8.3%	4.5%	124.2%	301.0	12/87
77	CTS	13.4	-50.7%	5.1%	63.7%	261.1	12/87
78	MAI Basic Four	13.2	73.4%	4.1%	47.6%	321.0	9/87
79	Convergent	12.9	-62.8%	3.3%	NA	384.8	12/87
80	Dynatech	12.6	1.5%	4.1%	37.3%	304.7	3/87
81	Watkins-Johnson	12.3	-9.6%	4.7%	47.0%	264.3	12/87
82	Paradyne	12.2	-40.8%	5.2%	52.0%	232.6	12/87
83	Tandon	12.1	49.3%	4.2%	52.2%	289.1	12/87
84	Andrew	11.7	13.9%	5.2%	70.3%	223.2	9/87
85	GenRad	11.6	0.5%	6.0%	66.0%	193.8	12/87
86	Applied Materials	11.5	-0.4%	6.6%	119.6%	174.4	10/87
87	ADC Telecommunications	11.1	10.3%	6.7%	47.5%	166.9	10/87
88	Cullinet Software	11.0	-59.2%	6.3%	-124.9%	174.9	4/87
89	Dataproducts	11.0	20.8%	3.2%	60.2%	338.8	3/87
90	Gerber Scientific	10.6	49.6%	4.7%	41.4%	223.9	4/87
91	Westmark International	10.5	-37.4%	3.6%	366.7%	291.9	12/87
92	Computer Associates	10.4	71.2%	3.4%	16.4%	309.3	3/87
93	BRIntec	9.4	18.7%	3.2%	73.5%	293.7	12/87
94	Genicom	9.4	105.6%	3.1%	37.8%	302.2	12/87
95	Marshall Industries	9.2	-14.8%	3.2%	143.7%	286.6	5/87
96	Micom Systems	9.1	8.1%	4.6%	45.7%	196.7	3/87
97	ISC Systems	8.8	29.3%	5.2%	68.4%	168.5	6/87
98	Coherent	8.5	-4.4%	5.3%	222.4%	159.0	9/87
99	Diebold	8.4	-43.3%	1.9%	29.7%	439.1	12/87
100	Fluke	8.3	-8.3%	4.0%	66.9%	206.3	9/87

Source: ELECTRONIC BUSINESS

(Continued)

Top capital spenders by segment

Capital expenditures
FY 1987

Semiconductors

	Total ($ millions)	As a percentage of revenue
Motorola	$658.0	9.8%
Texas Instruments	462.8	8.3%
Intel	301.5	15.8%
LSI Logic	174.5	66.6%
Advanced Micro Devices	137.9	13.8%
National Semiconductor	94.7	5.1%
Harris	83.6	4.0%
VLSI Technology	50.1	29.1%
Gould	49.0	5.2%
Analog Devices	43.0	11.6%
Western Digital	40.6	8.8%
International Rectifier	6.0	4.0%
Total, weighted avg.	**$2,101.7**	**9.8%**

Communications

	Total ($ millions)	As a percentage of revenue
Motorola	$658.0	9.8%
General Instrument	63.2	8.0%
M/A-COM	26.7	6.1%
Avantek	24.4	11.4%
DSC Communications	23.2	7.4%
Bolt Beranek and Newman	22.2	9.5%
Digital Communications	19.0	10.5%
General DataComm	15.3	7.6%
Dynatech	12.6	4.1%
Paradyne	12.2	5.2%
Andrew	11.7	5.2%
ADC Telecommunications	11.1	6.7%
Micom Systems	9.1	4.6%
Scientific-Atlanta	6.7	1.4%
3Com	6.3	5.7%
TIE/communications	4.3	1.7%
Aydin	4.1	2.8%
Dynascan	1.7	0.9%
Total, weighted avg.	**$931.8**	**8.2%**

Minicomputers

	Total ($ millions)	As a percentage of revenue
IBM	$4,304.0	7.9%
DEC	748.4	8.0%
Hewlett-Packard	507.0	6.3%
Data General	142.9	11.2%
Tandem Computers	142.4	13.7%
Prime Computer	100.5	10.5%
Sun Microsystems	76.1	14.2%
Apollo Computer	53.7	9.7%
Gould	49.0	5.2%
Stratus Computer	13.8	7.5%
MAI Basic Four	13.2	4.1%
Computer Consoles	4.9	3.3%
Total, weighted avg.	**$6,155.9**	**7.9%**

Office equipment

	Total ($ millions)	As a percentage of revenue
IBM	$4,304.0	7.9%
Xerox	937.0	9.1%
NCR	389.2	6.9%
Pitney Bowes	251.8	11.2%
Wang Laboratories	128.0	4.5%
Harris	83.6	4.0%
Datapoint	25.6	8.2%
Diebold	8.4	1.9%
Savin	1.2	0.3%
Total, weighted avg.	**$6,128.7**	**7.8%**

Mainframes

	Total ($ millions)	As a percentage of revenue
IBM	$4,304.0	7.9%
Unisys	720.9	7.4%
NCR	389.2	6.9%
Control Data	178.3	5.3%
Amdahl	157.8	10.5%
Cray Research	40.2	5.8%
Total, weighted avg.	**$5,790.4**	**7.7%**

Components

	Total ($ millions)	As a percentage of revenue
AMP	$171.8	7.4%
Molex	49.5	12.8%
AVX	31.8	11.7%
Augat	29.4	9.4%
Sprague Technologies	24.3	5.6%
Cherry Electrical	15.4	9.6%
CTS	13.4	5.1%
BRIntec	9.4	3.2%
Oak Industries	6.2	3.4%
Total, weighted avg.	**$351.2**	**7.6%**

Software

	Total ($ millions)	As a percentage of revenue
Microsoft	$58.0	16.8%
Lotus Development	26.6	6.7%
Oracle Systems	16.9	12.9%
Mentor Graphics	14.7	6.6%
Cullinet Software	11.0	6.3%
Computer Associates	10.4	3.4%
Ultimate	7.9	4.6%
Ashton-Tate	6.5	2.4%
Total, weighted avg.	**$152.1**	**7.5%**

Microcomputers

	Total ($ millions)	As a percentage of revenue
IBM	$4,304.0	7.9%
Compaq Computer	113.3	9.3%
Tandy	93.1	2.7%
Apple Computer	86.1	3.2%
Zenith Electronics	55.4	2.3%
Altos Computer	28.9	18.8%
Tandon	12.1	4.2%
AST Research	6.3	3.0%
Atari	4.1	0.8%
Total, weighted avg.	**$4,783.3**	**7.2%**

Peripherals

	Total ($ millions)	As a percentage of revenue
Storage Technology	$179.2	23.9%
Control Data	178.3	5.3%
Seagate Technology	78.4	8.2%
MiniScribe	50.5	13.9%
Applied Magnetics	25.7	12.1%
Micropolis	22.3	7.7%
Maxtor	17.4	9.9%
Tandon	12.1	4.2%
Dataproducts	11.0	3.2%
Genicom	9.4	3.1%
Wyse Technology	8.1	3.1%
AST Research	6.3	3.0%
Quantum	5.9	4.9%
Cipher Data Products	5.8	3.3%
Decision Industries	4.9	2.6%
Intelligent Systems	2.8	1.7%
Xidex	2.2	0.4%
Total, weighted avg.	**$620.2**	**7.1%**

Government

	Total ($ millions)	As a percentage of revenue
Motorola	$658.0	9.8%
GM Hughes Electronics	469.4	4.5%
Texas Instruments	462.8	8.3%
Honeywell	304.2	4.6%
Litton Industries	242.8	5.5%
Harris	83.6	4.0%
Singer	78.7	4.1%
E-Systems	51.1	4.2%
Gould	49.0	5.2%
Varian Associates	46.2	4.7%
Loral	34.2	5.0%
SCI Systems	29.6	5.4%
Cubic	17.1	4.7%
Watkins-Johnson	12.3	4.7%
Aydin	4.1	2.8%
Logicon	3.8	1.9%
Total, weighted avg.	**$2,547.0**	**5.9%**

Capital equipment

	Total ($ millions)	As a percentage of revenue
Hewlett-Packard	$507.0	6.3%
Perkin-Elmer	66.5	5.0%
Varian Associates	46.2	4.7%
Teradyne	41.0	10.8%
Tektronix	40.7	2.9%
LTX	13.6	11.3%
GenRad	11.6	6.0%
Applied Materials	11.5	6.6%
Gerber Scientific	10.6	4.7%
Fluke	8.3	4.0%
Sun Electric	4.6	2.3%
Esterline	2.7	1.0%
Total, weighted avg.	**$764.3**	**5.6%**

Computer-based systems

	Total ($ millions)	As a percentage of revenue
Hewlett-Packard	$507.0	6.3%
Honeywell	304.2	4.6%
Intergraph	43.7	6.8%
Recognition Equipment	21.7	8.2%
Gerber Scientific	10.6	4.7%
ISC Systems	8.8	5.2%
Coherent	8.5	5.3%
Measurex	6.9	3.0%
Sun Electric	4.6	2.3%
Total, weighted avg.	**$916.0**	**5.5%**

Medical

	Total ($ millions)	As a percentage of revenue
Medtronic	$28.4	5.7%
Westmark International	10.5	3.6%
Diasonics	8.1	3.0%
Total, weighted avg.	**$47.0**	**4.4%**

Distributors

	Total ($ millions)	As a percentage of revenue
Avnet	$47.3	3.1%
Marshall Industries	9.2	3.2%
Wyle Laboratories	3.8	1.0%
Pioneer-Standard	2.3	1.1%
Arrow Electronics	2.2	0.4%
Anthem Electronics	0.9	0.5%
Total, weighted avg.	**$65.7**	**2.1%**

Source: ELECTRONIC BUSINESS

Stop harping about Japan's electronics prowess

In terms of productivity, sales and net income growth, the top U.S. electronics firms outperformed their Japanese rivals last year

BY PAULA DOE

After two hard years, Japan's major electronics producers are starting to see results from their efforts to cope with the high-valued yen. Sales of the top 20 electronics companies in Japan revived to a healthy 9.9% growth rate for the fiscal year ended March 1988. And net income for the same group of companies surged 35.4% during the same time period.

Nonetheless, U.S. companies did better across the board (see accompanying table). Although sales of the leading U.S. electronics producers only slightly outpaced those of their Japanese counterparts, net income grew significantly faster. The top 20 U.S. electronics companies' net income surged 48.1% last year. The U.S. companies' aggregate net income was 7.5% of sales, roughly three times the Japanese percentage.

ELECTRONIC BUSINESS tracks the consolidated financial results for the 20 largest electronics companies in Japan. The Japanese figures (see accompanying table) are then compared against those from the top 20 U.S. electronics companies from our ELECTRONIC BUSINESS 200 listing, published in our July 15th issue.

In spite of Japan's intense efforts to improve productivity during the past couple of years, the U.S. sector made greater gains. While Japanese sales per employee were up 10.1%, the top 20 U.S. companies saw 12.4% improvement. And in terms of net income per employee, the Japanese growth of 38.1% was outpaced by the U.S. increase of 48.4%. In fact, U.S. productivity growth has been significantly higher for each of the past three years since ELECTRONIC BUSINESS began compiling these figures.

Revenue and earnings per employee are crude ways to compare productivity, since they reflect market forces as well as output. However, better measures are hard to come by and, whatever the actual levels, the rate of change in revenue and earnings per employee still suggest a general trend in productivity growth.

While the United States is increasing its productivity faster than Japan, the Japanese appear to still be more productive. The average Japanese revenue per employee of $211,400 was twice that of the United States. Still, the revenue-per-employee figures for Japan are artificially inflated by the web of affiliated firms that surrounds the major Japanese electronics corporations. Although the parent corporation's relationship with its affiliated supplier or distributor may be close, the parent typically does not own a high percentage of the affiliate, so the affiliate's workers are not counted in the parent's consolidated total of employees.

Furthermore, the Japan revenue-per-employee figures also looked huge last year because of the appreciation of the yen against the dollar.

Rod Thomas

In actuality, the figures for the top Japanese companies remain at only about 55% of their peak levels of 1984. U.S. revenue per employee, on the other hand, is up 16% from 1984.

Revenue figures aside, the U.S. top 20 far outpace their Japanese rivals in terms of income productivity. The average net income per employee figure for Japan was only $5,000, much less than the U.S. average of $7,900.

Kudos for the Japanese

Still, the Japanese deserve kudos for riding out the wild fluctuations in their currency. Japanese sales growth last year almost caught back up with U.S. levels. The 9.9% growth in yen-based electronics revenue at the big Japanese producers approached the 12.5% increase at the top 20 U.S. producers. In sharp contrast, Japanese sales two years ago were flat as the high yen devastated export sales. U.S. companies maintained 4% to 5% growth that year. The 9.9% growth in electronics sales outpaced the 7.1% increase in total sales at the Japanese companies, as producers began to successfully move to higher value-added products — fewer toasters and fans, more computers and VCR camcorders.

Mitsubishi Electric Corp. led the Japanese recovery last year with a dramatic 55% increase in electronics revenue. Oki Electric Industry Company Ltd. also made a significant comeback with a 19% sales growth, after a rough year in 1986. Fujitsu Ltd. saw an impressive 14% increase in revenue, while NEC Corp. and Omron Tateisi Electronics Co. both saw 11% growth in overall sales. On the other hand, Hitachi Ltd. experienced a 6% decline in electronics revenue, but the company's total sales increased 3%. Sanyo Electric Company Ltd. saw its sales dip 14%.

With growth reviving and the yen strengthening against the dollar, the leading Japanese electronics producers look bigger and bigger. The top seven companies in Japan now have electronics sales exceeding $10 billion each. To make last year's top 20 list, a company had to have electronics sales of at least $2 billion. In fact, total sales of the Japanese top 20 are now 15% more than those of the 20 largest U.S. producers, and come to some 58% of those of the total ELECTRONIC BUSINESS 200.

In addition to revenue, earnings for the Japanese also started to recover after plummeting in each of the past two years. Thanks to intensive cost cutting efforts, companies reported big percentage increases in earnings last year, although margins still remain extremely thin. Net income was up 35.4%, but remained a meager 2.6% of sales, reflecting no change from the 2% to 3% of the last several years.

A 579% growth

Of the Japanese top 20, Omron had the most impressive earnings gain. The company's net income last year swelled 579% to $166 million. Oki experienced a 144% surge in net income to $40 million. Mitsubishi saw a 110% gain. Sanyo, however, reported a net income loss of $140 million. The Osaka-based corporation, heavily dependent on exports, was

Japanese versus U.S. electronics companies in 1987*

	Japanese top 20	U.S. top 20
Electronics revenue ($ billions)	$173.1	$151.5
Change from 1986	+9.9%	+12.5%
Total revenue ($ billions)	$275.3	$154.2
Change from 1986	+7.1%	+12.2%
Net income ($ billions)	$6.8	$11.5
Change from 1986	+35.4%	+48.1%
Net income/sales	2.6%	7.5%
Revenue per employee	$211,400	$105,734
Change from 1986	+10.1%	+12.4%
Net income per employee	$5,000	$7,898
Change from 1986	+38.1%	+48.4%

Conversion rate: ¥ 125 = $1

* For Japanese companies, fiscal year ended March 1988

Source: ELECTRONIC BUSINESS

the only major Japanese electronics company to lose money last year.

Only a very few of the most successful companies managed to earn more than 10 cents on the dollar from operations and more than 4 cents in net income. Nippon Telegraph and Telephone Corp., with its lucrative domination of the telecommunications market in Japan, had operating income of 15% of revenue and net income of 4%. Kyocera Corp., with its domination of the worldwide ceramic package market, had operating income of 14% of sales, and net of 7.5%. Kyocera recently forecast a 23.4% increase in pretax recurring profits for the current fiscal year. TDK Electronics Company Ltd. also maintained its relatively healthy bottom line with operating income of 12% and net of 4.5%.

Everybody else had operating income amounting to 5% of sales or less, and net income of 3% or less. Reliable consolidated figures for other measures of return, such as return on equity or return on investment, were not yet available for most of the Japanese companies. □

Japan's top electronics companies in 1987

		Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Net income as a percentage of revenue	Revenue per employee	Net income per employee	Fiscal year ended
1	**Matsushita**[1]	$28,500	$38,552	$1,303	3.4%	$285,600	$9,600	3/88
	Change from 1986	11%	5%	-0.5%	—	—		
2	**NEC**	21,700	21,718	203	0.9%	212,000	2,000	3/88
	Change from 1986	11%	11%	69%	—	—	—	
3	**Toshiba**	17,100	28,579	486	1.7%	234,000	4,000	3/88
	Change from 1986	13%	8%	78%	—	—	—	
4	**Hitachi**	16,600	39,081	1,094	2.7%	248,900	6,800	3/88
	Change from 1986	-6%	3%	39%	—	—	—	
5	**Fujitsu**[2]	16,400	16,374	337	2.1%	172,700	3,600	3/88
	Change from 1986	14%	14%	95%	—	—	—	
6	**Sony**[1]	11,700	11,655	294	2.5%	192,600	4,900	3/88
	Change from 1986	10%	10%	-12%	—	—	—	
7	**Mitsubishi**[1]	11,400	18,946	178	0.9%	256,000	2,400	3/88
	Change from 1986	55%	12%	110%	—	—	—	
8	**Sharp**[2,3]	8,100	9,880	160	1.6%	184,700	3,000	3/88
	Change from 1986	12%	8%	-4%	—	—	—	
9	**Canon**	7,300	7,814	106	1.3%	208,200	2,800	12/87
	Change from 1986	8%	10%	24%	—	—	—	
10	**Sanyo**	5,700	9,491	-140	-1.5%	233,800	-3,500	11/87
	Change from 1986	-14%	0%	-933%	—	—	—	
11	**Ricoh**[3]	4,400	5,200	110	2.2%	185,700	4,000	3/88
	Change from 1986	11%	10%	28%	—	—	—	
12	**Oki**[3]	3,900	3,880	40	1.1%	192,600	2,100	3/88
	Change from 1986	19%	19%	144%	—	—	—	
13	**TDK**	3,200	3,186	145	4.5%	199,100	9,000	11/87
	Change from 1986	5%	3%	17%	—	—	—	
14	**Pioneer**	2,900	2,924	91	3.1%	225,000	7,000	3/88
	Change from 1986	3%	5%	111%	—	—	—	
15	**NTT**[2]	2,900	45,296	1,946	4.3%	155,600	6,700	3/88
	Change from 1986	8%	6%	64%	—	—	—	
16	**Alps**[2]	2,800	2,964	66	2.2%	197,600	4,400	3/88
	Change from 1986	0%	0%	107%	—	—	—	
17	**Omron**	2,400	2,414	166	2.6%	166,500	11,400	3/88
	Change from 1986	8%	11%	579%	—	—	—	
18	**Kyocera**	2,100	2,403	181	7.5%	150,200	11,300	3/88
	Change from 1986	12%	9%	30%	—	—	—	
19	**Citizen**[2,3]	2,000	2,200	40	1.8%	262,800	4,700	3/88
	Change from 1986	7%	4%	46%	—	—	—	
20	**Casio**[3]	2,000	2,040	40	1.8%	264,200	4,700	3/88
	Change from 1986	7%	12%	57%	—	—	—	

Conversion rate: ¥125 = $1

[1] Comparisons are with the company's last full fiscal year, ending 11/86 for Matsushita and 10/86 for Sony. Both companies recently changed their fiscal year and released only partial results for the period ending 3/87

[2] Consolidation by Japanese accounting conventions, which differ from U.S. Securities and Exchange Commission rules

[3] Preliminary figures before release of final consolidated results

Source: ELECTRONIC BUSINESS

What U.S. companies need to do Down Under

Through Australia's corporate partnership plan, U.S. computer companies must reach specific goals for local R&D and export

BY CRAIG ADDISON

Wanted: Foreign electronics companies to become "corporate partners." No experience necessary, just a commitment to R&D and export. Renumeration in the form of lucrative government contracts. Apply immediately to the Australian government.

And apply they have. In the 10 months since the government introduced its corporate partnership plan, overseas computer companies have been signing up at the rate of one a month. By becoming corporate partners, these companies are exempt from the government's offsets obligations, which require that 30% of the value of government contracts be sourced locally.

To qualify for the tag "corporate partner," a foreign company must spend 5% of its annual Australian turnover on local R&D and match the value of its imports with exported products. The partner must meet both stipulations within seven years, a challenge indeed for the Australian subsidiaries of U.S.-owned computer corporations that in the past have really only been shop fronts.

These "Partnerships for Development Agreements," as they are officially called, are the cornerstone of the Australian government's plan to stem a $3.2 billion a year trade deficit in information technology products. Under its Information Industries Strategy, the government has set a target of $1.2 billion in annual exports by 1995, and on paper it is well past the halfway mark, thanks to the export commitments of the country's foreign corporate partners.

To date, 10 multinational corporations have signed on the dotted line: Apollo Computer Inc., Apple Computer Inc., Cincom Systems Inc., Digital Equipment Corp., Hewlett-Packard Co., Honeywell Bull Inc., IBM, Sun Microsystems Inc., Unisys Corp., and Wang Laboratories Inc. If they meet their stated goals, these 10 will have eased the Australian balance of trade by $780 million by 1994 [see accompanying table]. In the same time frame, the companies will have reached a combined local R&D level of $174 million a year.

So far, U.S. computer companies dominate the corporate partnership ranks, but NEC Corp. is expected to become the first Japanese corporation to sign up. Other firms that are aiming for corporate partnership status include ICL Plc of Britain, Memorex Telex, Fujitsu Ltd. of Japan, NCR Corp. of the United States and West Germany's Siemens AG.

The Australian government has taken a hands-off approach, letting its corporate partners decide for themselves where to spend the money. However, bureaucrats and politicians are hoping that the program will encourage multinational companies to center their Pacific basin operations in Australia. Many of the companies, including Hewlett-Packard, IBM and Unisys, have chosen software development as the major component of their partnership activities. Others, such as Apollo's Australian subsidiary are channeling their R&D activities through locally owned companies.

Although the corporate partnership scheme is only in the embryonic stage, the government has declared it a great success. Mike Fitzpatrick, first assistant secretary of the light industries division in the Department of Industry, Technology and Commerce (DITAC), is confident that the existing rate of one new partner a month will be maintained

John Heaton/Stock Boston

throughout the near future.

Now that the government has signed up most of the major U.S. computer hardware companies, Fitzpatrick says international software firms are on the hit list. After that, communications equipment suppliers will be the next target.

Tipping the balance

As well as tipping the balance of trade by encouraging multinationals to export from Australia, the corporate partnership plan is designed to give Australian-owned companies access to world electronics markets. A number of small indigenous firms have already benefited by jumping into bed with foreign corporations.

Pulsar Electronics Pty Ltd., a small computer design company, has teamed up with Honeywell Bull in a deal that opens export doors for the Melbourne-based firm. As well as selling thousands of Pulsar workstations to Telecom Australia, Honeywell Bull is manufacturing the workstation processors in Sydney and plans to ship the product to other countries. Pulsar has a good track record when it comes to designing innovative products, but has suffered setbacks in trying to penetrate world markets, a typical plight of many Australian electronics companies.

Another Australian firm that has broken into high-volume overseas sales thanks to a corporate partner is LSE Manufacturing Pty Ltd. of Sydney. The small printed circuit board assembly company is shipping loaded and fully tested boards to Apple's Singapore factory. The deal will boost LSE's annual sales by $4.8 million, but that's only the beginning. A second contract with corporate partner Apple Computer Australia will see LSE manufacturing a further 30,000 boards a month.

The partnership scheme is also expected to create thousands of new jobs over the next several years. But this anticipated increase has many executives from Australia's electronics companies worried. In an industry already suffering from shortages of skilled technical staff, several such executives are wondering where the multinationals are going to find capable employees.

Some local companies are afraid that their small R&D labs may become hunting grounds. The Australian Computer Equipment Manufacturers Association (ACEMA) recently surveyed more than 30 of its members and has already found "strong indications of poaching by transnational companies," according to Don Dryden, president of the group. Dryden's own company, Labtam Ltd., is one of the biggest R&D spenders in the indigenous industry, with an R&D staff of 30 employees and an annual budget of $1.6 million. He is concerned that corporate partners like IBM Australia Ltd., with a commitment to eventually spend more than $60 million a year on R&D, could wipe out the local R&D industry overnight if it recruited staff within Australia.

The corporate partner plan could, however, create a labor shortage

Indeed, an overheated job market would push up labor costs, according to Peter Rehn, general manager of Computer Sciences of Australia. He argues that, particularly in markets where margins are low, local companies could go out of business if labor rates increase substantially.

Government officials say they are addressing the people problem by working to increase substantially university enrollment in technical fields. However, for the short term, the plan is to carry out retraining courses to increase the skills of people already working in industry, and to relax Australian immigration laws to attract qualified overseas workers.

Hewlett-Packard Australia Ltd. has estimated that its partnership activities will create more than 300 new jobs, but denies the need to poach from local companies. "We have access to a worldwide network of people. We don't have to steal from the 'little Aussie battler,' " contends HP Australia's managing director Malcolm Kerr. "If anything, we give more people to local industry than we take from them."

While the corporate partnership program has been hailed by many, the plan does have its critics. Richard May, a former Australian government trade commissioner and now a computer industry consultant, believes the root of the problem lies with the attitudes of government purchasing officers. "We have to get out of the mold of thinking that imported products are better," he says. May argues that Australia should emulate the policies of the United States, Canada, West Germany and others, in giving preference to indigenous companies. He adds that the corporate partnership scheme was just an attempt by the government to get foreign multinationals to solve the country's balance of trade problem. □

Conversion rate: U.S. $1 = Australian $1.24

Australia's corporate partnership program

Company	Annual local R&D* ($ millions)	Annual Australian exports* ($ millions)	Major partnerships; activities
Apple Computer	$14.5	$86.3	Transfer of manufacturing technology; joint R&D programs
Apollo	NA	8.1	Joint ventures in niche computer products
Cincom Systems	NA	37.9	Software development; education/client services
DEC	20.2	80.6	Computer communications products; software development
Hewlett-Packard	17.7	62.9	Fourth generation languages; computer communications products
Honeywell Bull	8.1	40.3	EFT/POS equipment, education/training services; Asian/Pacific board repairs
IBM	60.5	274.2	Software development; PC manufacturing; education/technical services
Sun Microsystems	7.2	28.2	Technology transfer; software/hardware development; training services
Unisys	28.2	104.8	Software development; education/training services
Wang	17.3	56.4	Encryption systems; joint ventures
Total	$173.7	$779.7	

Conversion rate: Australian $1.24 = U.S. $1

* Amount to be achieved by 1993-1994

Source: ELECTRONIC BUSINESS

SCL in India: A passage to semiconductors

As India's economy moves toward capitalism, Semiconductor Complex Ltd. ramps production up to satisfy a budding electronics industry

BY RAJU CHANDRASEKAR

Virendra Mohan could well be called the maharajah of India's chip industry. Chairman and CEO of Semiconductor Complex Ltd., located in Chandigarh, near New Delhi, Mohan has managed to bring on line a $50 million fab which currently manufactures 2 million semiconductors monthly. "This," he boasts, "is in the same country where still an efficient bullock cart is being designed."

SCL's accomplishments are indicative of India's growing presence in the worldwide electronics industry. The country's electronics production surged 21.7% to $3.7 billion in its latest fiscal year ending last March, according to market research firm Dataquest Inc. of San Jose. In regard to components, including semiconductors, production grew 9.4% to $477 million during the same time period.

Admittedly, SCL's large-scale integration chip fab pales when compared to those in the United States and Japan. But Mohan discloses an aggressive plan to reach VLSI (very large-scale integration) levels soon. According to him, SCL is spending $15 million to implement a pilot line for 3-micron to 2-micron geometries and the company will achieve 1.2-micron capability by 1989. Because SCL's order book is full for the next 12 months, Mohan plans to double his fab's production during 1989.

Spending 30% of sales on R&D, Mohan's goal is to migrate from calculator and watch semiconductors to more advanced chips such as ASICs. SCL has plans for 10 chip-design centers to be scattered throughout India's major high-tech regions. To acquire the technology to move upmarket, Mohan is very keen on establishing joint ventures with U.S. partners.

The AMI connection

From the beginning, Mohan has had experience with Yankees. SCL's fab was actually set up five years ago by the Indian government with help from American Microsystems Inc. (AMI) of Santa Clara, Calif., which was subsequently bought out by Gould Inc. SCL started off by building chips from AMI's designs.

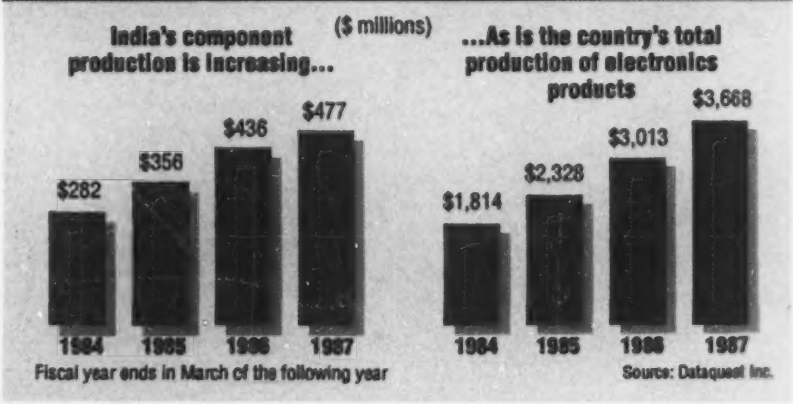
Not surprisingly, SCL's fab — which houses the capability to do mask making, wafer fabrication, assembly, packaging and testing all under the same roof — has a definite American flavor. Currently run with 800 employees, the plant uses production and test equipment purchased from Eaton Corp., EG&G Inc., Fairchild Camera and Instrument Corp. (acquired by Schlumberger Ltd.), GCA Corp., and Varian Associates.

At the outset, SCL's plans to pump $50 million into a chip fab were considered brash. However, the company's risky strategy seems to be paying off. After losing money the first few years of operation, SCL reported cash profits on revenue of $15 million in its most recent fiscal year, ended last March.

And revenue could surge in the future as the Indian government begins pumping money into expanding the country's telecommunications industry. Government officials have announced plans to invest $30 billion to implement 16 million more phone lines by the turn of the century. Because of its indigenous origins, SCL gets preferential treatment from the Indian government, which has already proved valuable in winning defense-related work. The defense semiconductor market in India, roughly estimated at around $200 million this year, is believed to be double that of its civilian counterpart.

In addition, SCL stands to benefit from rising labor costs in the Pacific Rim. India's 60 cents per hour wage for electronics equipment operators is among the world's lowest. The comparable labor figures for South Korea, Taiwan and Thailand are $2.50, $2 and $1.15, respectively. □

India's electronics production



PCs make it easier to collect and analyze data

Standalone data acquisition products are giving way to personal computer-based systems that not only log information, but make sense of it as well

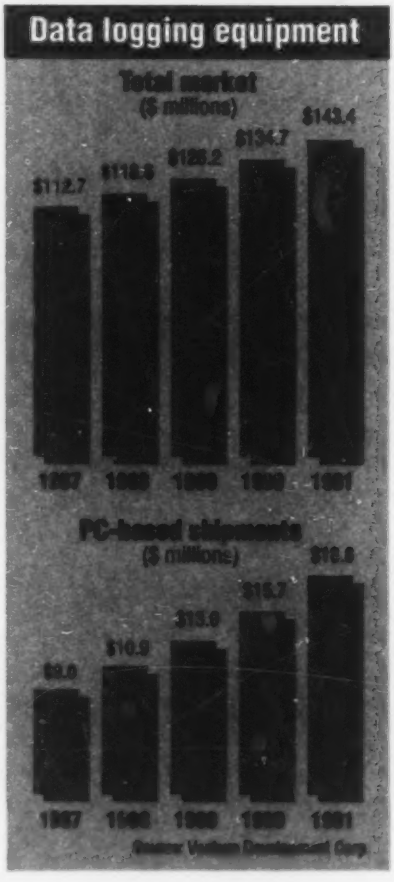
BY SYLVIA TIERSTEN

For many years, standalone data loggers have measured such factors as temperature, pressure and speed of products and processes in the laboratory and on the factory floor. Then came the personal computer. Suddenly, data logging was more than a routine check of routine functions. PC-based systems not only take numerical measurements; they analyze the data as well. And they do it without a big, expensive mainframe.

"People who are already drowning in numbers don't want more numbers; they want information," explains James Pinto, president of Action Instruments Inc., a San Diego-based manufacturer of data acquisition systems. "They want a readout that says, 'Please check boiler seven.'"

As a result, demand for PC-based data acquisition hardware and software is expected to grow an average of 20.8% a year through 1991, according to Venture Development Corp., a Natick, Mass., market research firm. By then, PC-based systems will account for about $18.8 million of a total $143.4 million market. By contrast, Venture Development predicts that in the same period, demand for standalone data loggers will increase less than 2% a year in dollars — from $59.6 million last year. Actual unit volume, however, will rise about 5%, because shipments of lower priced, hand-held data loggers will dominate.

It's not just former users of standalone devices that are buying sophisticated PC-based equipment. Operations that have relied on costly mainframe and minicomputer-based data collection systems also are interested in the price/performance characteristics of the PC entries. PC-based data collection and display systems cost an average of $8,000 to $10,000 today, according to Automation Research Corp., a Medford, Mass., market analysis firm. This price includes a microcomputer; a coprocessor for handling data in real time; monitor; interfaces; I/O boards; and data acquisition software. And if software packages decline from $2,500 in 1988, to $1,500 in 1991, as Automation Research's project director Dan Cretu anticipates, overall system costs will decline as well.



Right now, though, "It's a fairly competitive market price-wise," says Robert Judd, marketing vice president for MetraByte Corp., a Taunton, Mass., maker of plug-in boards and PC-compatible external systems. In recent years, prices and gross profit margins on boards (from 40% to 60%) have been "roughly maintained," he says. "If you can make 10% after taxes, you are doing very well." Pinto considers 90% for software and 50% for hardware "reasonable gross margins" but suspects that "some people are getting 20% on hardware and 30% to 40% on software."

PCs not perfect

Standalone equipment, meanwhile, ranges from $300 to $10,000. At the high end of the standalone market are products that offer more accuracy and faster sampling rates than PC-based technology. "In the PC arena you can't sample at gigahertz rates," says Melodie Summersett, national sales manager for National Instruments, an Austin, Texas-based vendor of IEEE-488 instrument control. Low-end data loggers "are viable if people have them already," says Summersett, and they will eventually give way to PCs. To stay in data acquisition, he says "it looks like a lot of vendors of traditional data loggers will also offer board-level solutions."

Environmental conditions sometimes preclude use of a PC-based system. Disk drives, for instance, may have difficulty withstanding excessive heat or vibration. Despite an emerging market for hardened, battery powered personal computers that can survive in a wide temperature range, "you still find simple-to-use data acquisition tools without a keyboard in these environments," says David Postetter, data acquisi-

tion marketing manager for John Fluke Manufacturing Company Inc., Everett, Wash. But many of these systems, unlike their earlier counterparts, produce files that may be transferred to a PC for analysis and report generation.

Today's PC-based data collection market is populated with small, start-up software companies, makers of plug-in I/O boards for personal computers, and control and instrumentation vendors who have branched out from dedicated data loggers to PC-controlled devices. On the software side, Lotus Development Corp. recently exited from data acquisition by selling its Lotus Measure package to National Instruments.

Measure, a PC-based software system for scientific applications requiring data capture and instrument control, includes a set of drivers for Lotus 1-2-3 and Symphony that permits acquisition, formatting and storage of data directly into the spreadsheet. For the maker of general purpose spreadsheets, the anticipated volume simply wasn't there.

Various options

Adapting the PC to the data acquisition operation can be accomplished in one of three ways. Least expensive is the printed circuit board level product with a rear connector for attaching input and output signals. Another approach, expansion chassis architecture, has the PC connected by cable to a separate "box" that holds the data acquisition I/O modules. Some are fully controlled by the PC, while others are "intelligent" and contain microprocessors.

A third option is to place digital logic and digital-to-analog converters on a plug-in card that is attached to a box via a cable. Electrically sensitive functions, including signal connection and conditioning, and analog-to-digital conversion, are performed in the external box.

The option card market is somewhat "price sensitive, since there is a maximum perceived price for anything that plugs into a PC," notes George Nadzam, marketing manager for the Data Acquisition and Control Division of Keithley Instruments Inc.

PC data collection sales will grow almost 21% a year through 1991

While until now, PC-based data acquisition applications have been centered within the laboratory research community, they are now headed for the factory floor. Laboratory Technologies Corp., for instance, a Wilmington, Mass., firm, named itself and its Labtech software line for its initial target market. Three years ago, recalls company president Frederick A. Putnam, "our sales were 60% academic research lab and 40% industrial research lab. Academics tend to be early adopters of new technology." Now, Putnam estimates, the ratio has shifted to 30% academic and 70% mainline industrial research. The next step, he anticipates, is the move of PC-based data acquisition systems from the industrial laboratory to the factory floor to bolster quality control.

Automation Research's Cretu sees the laboratory sector for PC-based data capture as "pretty well saturated." Data gathering for plant management, formerly the province of the minicomputer, is a potential growth area. But the hottest up and coming sector, he thinks, is in shop floor data collection and control.

Once a software user obtains diagnostic information, such as the number of vibrations per second and machine failures, "the next level of utility is event control," notes Action Instruments' Pinto. He estimates that 20% of the time his company's CIMPAC software package is used for controlling purposes in addition to data capture and analysis.

With few exceptions, PC-based data acquisition software products tend to be generic rather than application or industry specific. The market is "extremely broad and cuts across all disciplines and industries," says Putnam, including aerospace, automotive, chemical, medical, semiconductor and general manufacturing. What chiefly inhibits market growth, he thinks, is that "users of oscilloscopes and chart recorders have to be converted to doing something a different way." □

PC-based data logging now comes in two flavors

Until recently, you could have any operating flavor you wanted in the PC-based data acquisition world — as long as that flavor was DOS. Now, it appears, users have a choice beween IBM-compatible and Macintosh environments.

Some vendors, such as World Precision Instruments Inc. in New Haven, Conn., are specifically targeting scientific and engineering users of Apple Computer Inc.'s Macintosh. World Precision makes MacLab, a hardware/software data acquisition package that replaces storage oscilloscopes and polygraphs. The hardware unit can be linked to the modem port of any Macintosh computer.

Several vendors of IBM-compatible products are hedging their bets by creating Macintosh versions of existing lines. Laboratory Technologies Corp. of Wilmington, Mass., for instance, recently unveiled a Mac-based modification of Notebook, its IBM-based data acquisition program for scientific research and industrial process control.

Asyst Software Technologies Inc. of Rochester, N.Y., a wholly owned subsidiary of Keithley Instruments Inc., currently confines itself to the IBM world, but is weighing the merits of taking on the Big Apple. "We feel that the Macintosh is gaining share in the laboratories," notes company president and CEO Hermann Hamm. Eighteen months from now, he predicts, 80386-based PCs and Mac IIs will dominate the PC-based data acquisition market.

"We have noticed in our business that Mac IIs are replacing some of the Digital Equipment Corp.'s business," says Melodie Sunmersett at National Instruments in Austin, Texas. Hewlett-Packard Co. users, who shied away from the IBM-PC world, "are moving toward the MAC because they feel comfortable with the user interface." □

Hybrid circuit vendors size up the MMIC challenge

New defense demands and potential satellite markets mean good growth in MMIC chips. Hybrid makers are tuning in

BY JAN MURPHY

The makers of hybrid microwave integrated circuits (HMICs) are facing tactical changes in their military and commercial markets — changes caused by gallium arsenide semiconductor technology.

Analysts say that HMIC manufacturers are now facing an expensive shift away from using discrete components in HMICs to using monolithic microwave integrated circuits (MMICs), which are being manufactured as gallium arsenide-based chips. As the technology develops, MMIC chips will eventually reduce the overall cost of HMICs. Yet the initial expense for developing MMIC technology runs in the tens of millions of dollars — expenses that include new equipment, new personnel, and GaAs materials processing.

The main push to develop MMIC technology is coming from the military, the largest HMIC market, to reduce its overall cost of applications requiring hybrids. Some companies, such as M/A-COM Inc. of Burlington, Mass., and Watkins-Johnson Co. of Palo Alto, Calif., are already developing the technology based on a combination of military and corporate research funds.

Commercial markets for some companies will also be affected by MMIC technology. Analysts predict that the technology will be a large part of a new and potentially huge consumer communications market — direct broadcast satellite (DBS).

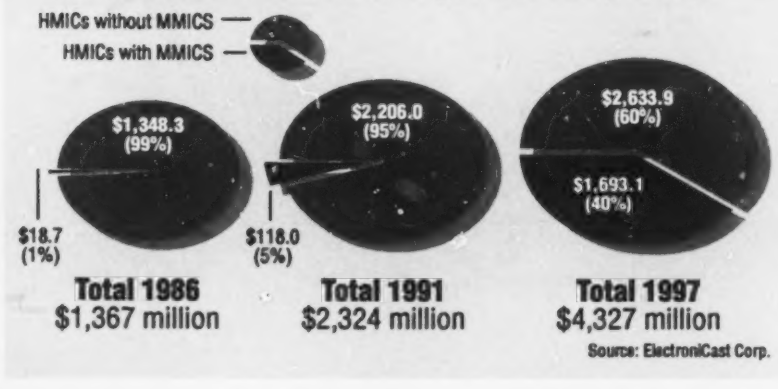
HMICs are typically thin-film circuits built on ceramic substrate. The primary use of HMICS has been for military applications, where the circuits are used in applications that require both resistance to extreme heat and small size — applications such as radar, missile guidance and communications systems.

Development of MMIC technology has everyone excited because a single MMIC chip could replace several of the components assembled on each circuit, while improving the performance of the circuit.

Jeff Montgomery, chairman of San Mateo, Calif., market research firm ElectroniCast, confirms that the shift toward employing MMIC chips is "the biggest single issue" in the HMIC market. He estimates that the use of MMICs in hybrid circuits will grow from 1% in 1986 to 5% in 1991, and up to 40% in 1997. This translates into a MMIC market that will increase from $18.7 million in 1986 to an estimated $1.7 billion by 1997.

Microwave IC market

MMIC penetration of North American hybrid MICs market ($ millions)



Source: ElectroniCast Corp.

Rosy markets

ElectroniCast's rosy market figures are based on the expected emergence of GaAs-based chips and their parallel to the emergence of silicon chips. In the case of silicon chips, once manufacturers figured out how to mass produce the silicon material cheaply, both the chips and the printed circuits on which they were assembled became cheaper and more powerful. If history is any indication, a circuit employing gallium arsenide chips could start a similar revolution in hybrid circuit manufacturing.

Robert Hamilton, product manager for MMICs at Varian Associates Inc., in Palo Alto, says, "In the long run, there will probably be some labor saving involved," although not in the short term. He estimates that the Solid State Operations California division of Varian, which is responsible for MMIC development, has $15 million invested in MMIC research to date.

Hamilton notes that many of the same manufacturing techniques HMIC manufacturers now use to create circuits can also be used to create a hybrid MMIC circuit. But he adds that to make hybrid MMICs cost effective, the MMIC chips "certainly have to be lower in price."

Mark Rosenzweig, group vice president of the Components Group at Adams-Russell Electronics Company Inc. in Waltham, Mass., focuses

on the future benefits of MMICs by saying, "If you can process everything in one shot, rather than assemble the different components, they're cheaper circuits." Fewer components, he adds, can also mean less time to test for each component's integrity.

Rosenzweig estimates that Adams-Russell uses MMIC chips in 5% of its military HMIC circuits and subsystems. He expects that figure to go as high as 25% in the next five years.

Some companies, such as California Amplifier Inc., buy the MMIC chips from other manufacturers, but assemble their own hybrid MMIC circuits. John Ramsey, regional sales manager for microwave products at California Amplifier, says, "We are already utilizing some MMIC technology." Ramsey thinks one of the company's bigger expenses will be in employing MMIC circuit and subsystem designers. He estimates that California Amplifier's use of MMICS will increase from 5% to 20% in the next five years.

MIMIC program

The Department of Defense is currently funding a seven-year research project concerning the manufacturing and use of microwave and millimeter wave monolithic integrated circuits, dubbed the "MIMIC" program.

Phase 0 of the MIMIC program, a one-year feasibility study, ended this past January. Phase I of the MIMIC program will run from 1988 through 1991, and contracts were awarded this past May to the prime contractors of Martin-Marietta Corp./ITT, $49.3 million; TRW Inc., $57.5 million; Raytheon Corp./Texas Instruments Inc., $68.6 million; and GM Hughes Electronics/General Electric Co., $50 million.

Phase I goals are to develop the technology to mass produce affordable MMIC chips that will be used in applications such as phased-array radar, electronic warfare, and smart munitions systems. James Fallon, vice president at M/A-COM, a subcontractor of MMIC chips to the Hughes/GE team, says that "MMICs are the fundamental base" for new military systems such as phased-array radar, which will be used in military planes and could also be used in radar for commercial planes.

More so than new systems, on which the military is cutting back, Fallon and other military contractors belive that MMIC technology will be big in the retrofit market, upgrading existing equipment such as F-14s and F-16s.

Thomas K. Wilson, manager of component marketing at Watkins-Johnson, says that "a major part of this program is to identify applications — for the MMIC to be effective, it has to be mass produced." He adds that the shift to MMIC technology "is a major step, but it is a slow evolution." (Watkins-Johnson is a subcontractor to the Martin-Marietta/ITT team.)

The main push to develop MMIC technology is coming from the military

While only a few companies have been selected for the military's MIMIC project, experts agree that nearly every HMIC manufacturer will benefit from the results of the project.

But other HMIC vendors are keeping an eye on commercial applications of MMIC — like DBS, a medium that will allow consumers to receive direct broadcasts from satellites.

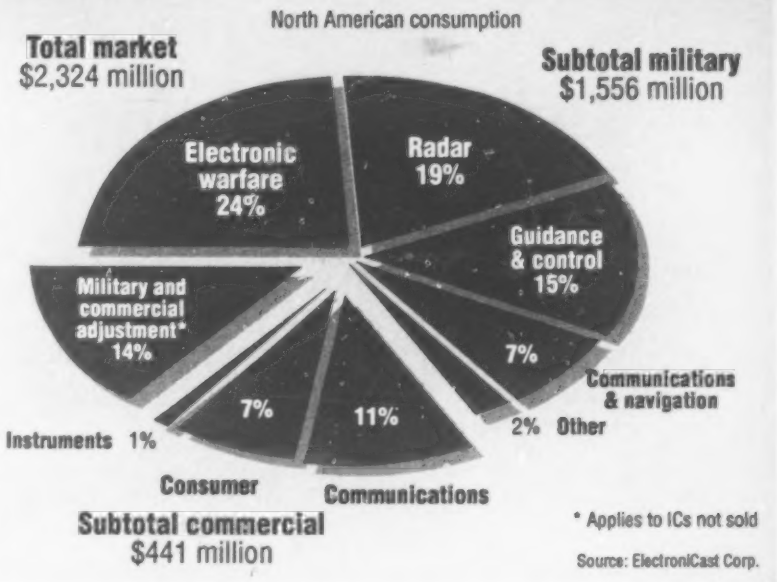
"DBS will be big," says William Strauss, president of Tempe, Ariz., market research firm Forward Concepts. He estimates that by 1991 or so, DBS applications will become more common.

DBS is being considered as an alternative to commercial and cable television. Consumers would need a receiver that was powerful enough to decode the satellite broadcasts and that would cost the consumer about as much as a fancy television.

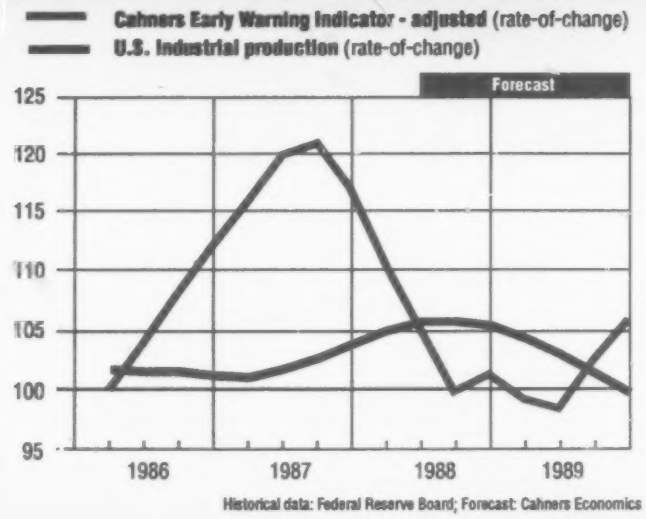
There are some problems, however. To pay for the service, says Strauss, the broadcast signals would most likely be scrambled the way that cable signals are scrambled. Then too, the receivers — mini-satellite dishes — would be expensive to produce initially, so there would have to be a large market.

Some North American companies that were gearing up for the DBS market in the mid 1980s were disappointed when the market was grounded by Federal Communications Commission regulations and by the difficulty of launching any satellites in the wake of the space shuttle disaster. During this time, however, foreign firms like The Plessey Company Plc and N.V. Philips GL took the lead in DBS and still hold it. Some American companies have sold, or are planning to sell, their satellite divisions. For example, M/A-COM sold off its $220 million Cable/Home Telecommunications subsidiary just two years ago, choosing instead to concentrate on the military market. □

Hybrid microwave IC applications — 1991

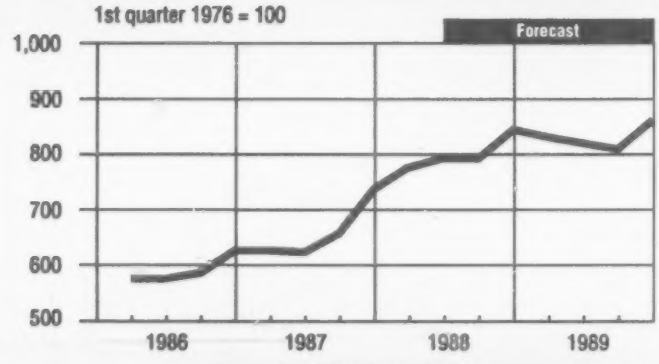


U.S. economic indicators



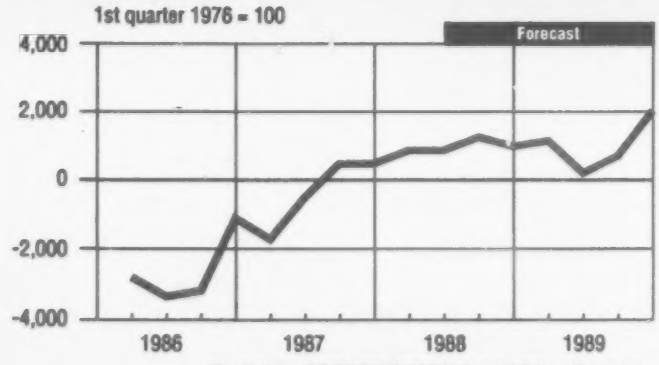
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Automatic test equipment — Revenue index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Automatic test equipment — Profits index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

U.S. production growth to remain steady until 1989

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

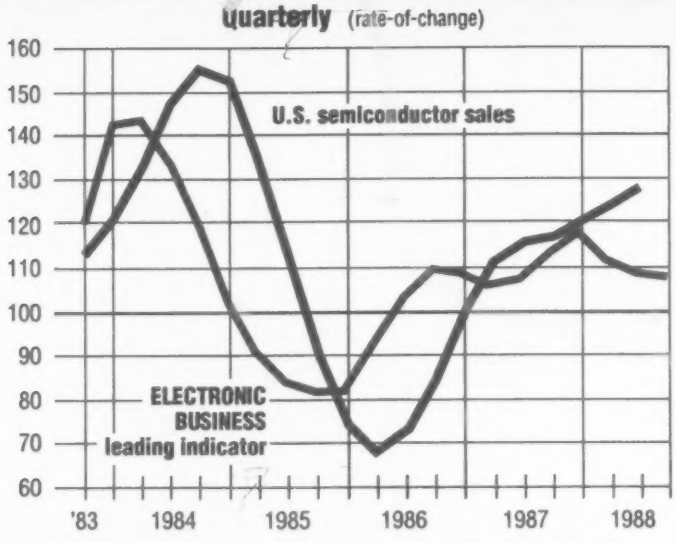
More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

ATE revenue and profits continue to improve

Manufacturers of automatic test equipment continue to see sales climb. In the second quarter of 1988, ATE worldwide sales rose almost 21% to $537 million, up from $526 million in the first quarter. Sales showed an even stronger 27% gain over the year-ago quarter's $423 million. The demand from computer and semiconductor manufacturers for automatic test equipment is expected to continue strengthening through the rest of this year. For the year, worldwide sales are expected to rise a sharp 21%, followed by a mild 3.6% increase in 1989.

ATE manufacturers returned to profitability in the second half of 1987 and are expected to remain so through 1989. During the second quarter, profits were down slightly from the prior quarter, but well above the losses of a year ago. Over the next three quarters, profits are expected to show healthy increases with a slowdown forecast in mid-1989.

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368

The ELECTRONIC BUSINESS leading indicator held steady in June at 108.4, not far off from the 108.3 revised May value. Still, the extremely slow downward path of the indicator is expected to continue through part of next year. The indicator predicts a mild slowdown, but no crash for the electronics industry in 1989.

Source: Cahners Economics

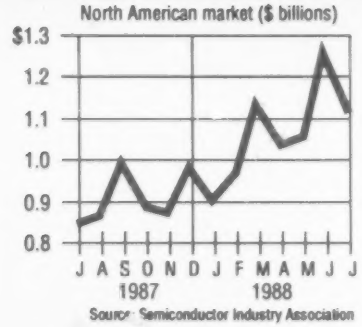
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, June)	108.	108.5	108.2	111.8
U.S. semiconductor bookings ($ millions, 3-month average, July)	$1,260	$1,269	$985	$951
Weekly hours of semiconductor production workers (monthly average, June)	40.1	40.2	40.9	40.6
Electronic components leadtime index (1977 = 100, August)	117.9	123.2	120.3	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, July)	61.1	64.6	68.9	65.5
Change in electronic components inventories ($ millions, SA, June)	+$101	-$2	+$885	+$47
Contract and orders for plant and equipment ($ billions, SA, June)	$39.3	$36.0	$35.9	$34.5

SA = seasonally adjusted, all other data is not seasonally adjusted

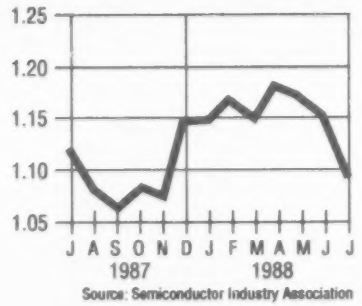
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *ELECTRONICS PURCHASING* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Source: U.S. Commerce Department

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FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES WORLDWIDE

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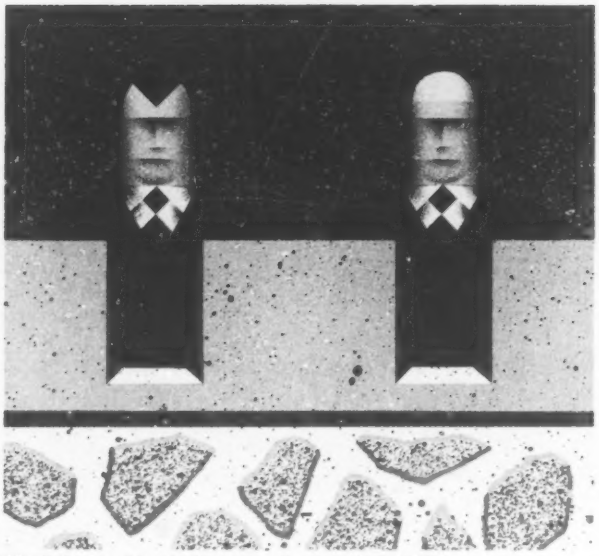
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 20 OCTOBER 15, 1988



PAGE 38 Inside the fortress: Europe after 1992

Special Report/Europe

38 Inside the fortress: Europe after 1992

With the so-called "United States of Europe" less than four years away, many European electronics companies worry that free trade within the Common Market alone may not be enough. They realize that they must expand worldwide sales volume to achieve the economies of scale necessary to finance high-technology growth. For American electronics firms, the time to start mapping corporate strategy for the pending new era of European market integration is here. And the approaches are varied.

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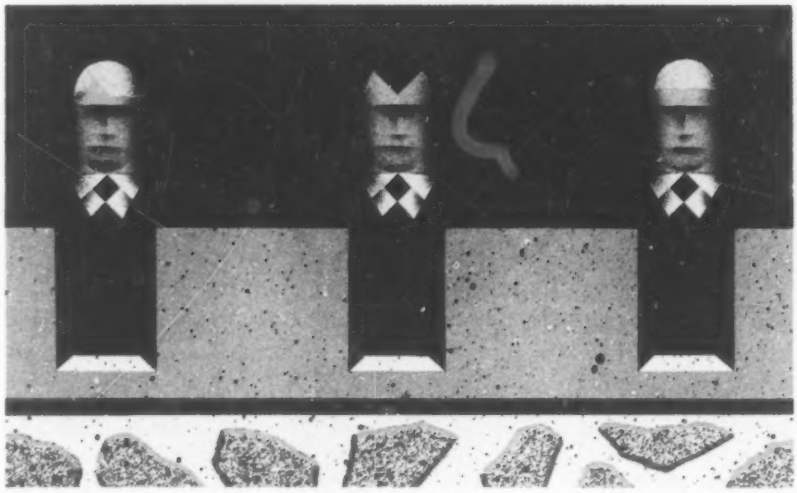

Euro-tactics

Back in the early 1970s, when the idea of a common European economic market was first put into practice, the vision was of a true "United States of Europe," an economic titan that would easily match the commercial might of the United States and Japan.

But until recently, there's been little prospect of that happening. From the business point of view, the European nations have remained a fractious, narrow-minded lot, always more ready to expand national trade interests than to pull for the greater good of the European Economic Community.

Now, though, that appears to be changing very fast. A whole new set of EEC trading rules is being enacted for a deadline of 1992 — rules that are not merely sweeping aside trading barriers between, say, France and West Germany, but which will radically change the global business picture for electronics companies.

Consider this: that the wave of mergers and acquisitions washing through Europe's electronics industries — Plessey taking over Ferranti's chip business, SGS and Thomson merging, to name just two — will leave a nest of industrial giants with the strength to defend their own markets and attack others like never before. That U.S. and Japanese companies may need to think again if they think they can raise all the necessary funds for their European operations in the City of London. That major Euro-traders like IBM will find it easier than ever to sell without the costly and time-consuming need to warehouse all across the continent.

The outcome of Europe 1992 — whether it protects Europe's markets or leaves them wide open — is by no means certain, as contributing editor Sherry Buchanan explains in our special European section. She did find, though, that those already "inside" — and that includes non-Europeans — will have a clear competitive edge. Those who aren't, who don't bother finding out how to deal with the new single market, are likely to lose out. To help U.S. electronics firms not yet doing business "over there," contributing editor Marty Chase provides a guide to some of the shortcuts.

JOHN KERR, managing editor

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Network nerve: OEMs team to help OS/2 topple NetWare

Should LAN vendors and their suppliers take sides in the battle brewing over OS/2-based PC networks? It may depend on which way IBM jumps

A battle is brewing in the local area networking world, as a number of OEMs prepare to introduce products based on a new network operating system.

Jointly developed and marketed by Microsoft Corp. of Redmond, Wash., and Santa Clara, California-based LAN vendor 3Com Corp., the new system — called the Microsoft OS/2 LAN Manager — aims to exploit the potential of networked personal computers running the OS/2 operating system. It also aims to displace Novell Inc.'s NetWare software as the network operating system of choice for connecting personal computers.

At stake is the lion's share of a burgeoning LAN marketplace. By the end of 1987, the U.S. installed base of PC LANs was worth about $3.5 billion, according to Kim Myhre, vice president for research and consulting at the Business Research Group, a Cahners Publishing Co. subsidiary. Myhre expects 1988 LAN shipments to add $1.5 billion of value to that base.

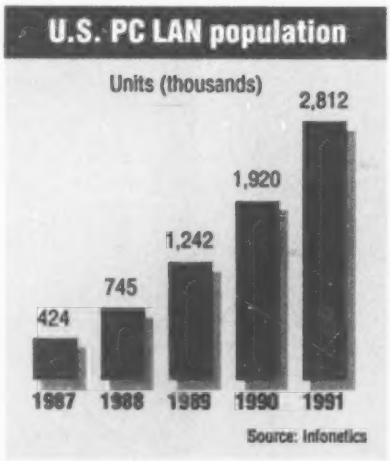
In unit terms, America's PC LAN market is expanding at a 54.5% compound annual growth rate, says Tom White, chairman of Infonetics, a Santa Clara-based market research and consulting firm. He predicts the 1987 installed base of 424,000 LANs will almost double this year, with 321,000 new LANs shipped in 1988. By 1991, White estimates, annual LAN shipments in the United States will reach 892,000.

Both hardware and software vendors are positioning themselves to reap the benefits of this explosive market. Backplane circuit boards and standalone adapter units are required to link personal computers, printers, disk drives and other equipment to the network media, and to connect LANs with one another and with wide-area networks. Meanwhile, software of all types is in demand, to establish basic communications protocols, to provide applications that run over the network and to oversee and manage the networks' overall operation.

This last function is addressed by network operating systems, and has become all but synonymous with Novell's NetWare product in the PC LAN environment. By mid-1988, Provo, Utah-based Novell had licensed approximately 220,000 copies of NetWare, representing 50% to 60% of the installed base of PC LANS. Not only is NetWare popular, it has managed to achieve "standard" status in some quarters, says analyst White. "Our research indicates that approximately 25% of the companies networking personal computers have standardized on NetWare," he says. "They simply won't install anything else."

Fly in ointment

The fly in NetWare's ointment is that it was created to run in a world largely populated by IBM and compatible personal computers running the MS/DOS (PC/DOS in IBM parlance) operating system. But in April 1987, IBM introduced its new generation of PCs, the Personal System/2s, running a new operating system, OS/2. OS/2-based computers have yet to make much of a dent in the marketplace, but such machines are expected to become the de facto standard in coming years.



Enter the Microsoft OS/2 LAN Manager. As its name implies, the product is designed to exploit the increased power and flexibility of 80286- and 386-based PCs running the multitasking OS/2 operating system. Still, the LAN Manager is not meant to be the last word in PC LAN operating systems in and of itself. Rather, it provides a range of basic networking functions and, most importantly, offers a series of application programming interfaces (APIs) upon which OEMs and software developers can build.

To attract OEMs to the LAN Manager fold, Microsoft and 3Com held a series of developers' conferences this spring and summer. More than 1,000 people attended, and as of late June, 3,000 to 4,000 LAN Manager development kits had been shipped, according to Eric Benhamon, vice president and general manager of 3Com's Software Products Division. By that point, Microsoft had signed up 35 OEMs committed to creating products based on the LAN Manager product.

The LAN Manager enthusiasts include big names like: Apollo Computer Inc.; AT&T's Information Systems operation; Compaq Computer Corp.; NCR Corp.; NEC Corp.; Nixdorf Computer AG; Tandem Computers Inc.; and Tandy Corp.'s Radio Shack division.

Thanks to its privileged position as a joint developer of the product, 3Com is likely to be the first OEM shipping a system based on the LAN Manager — the 3+Open network operating system, scheduled for release this month. The LAN Manager portion of 3+Open provides file-sharing and print-sharing functions

Mr. "I'm not scared." Mark Calkins, marketing vice president for Novell's Software Group, argues that growing support for LAN Manager from OEMs and software houses won't shift development activity away from NetWare

Ed Rosenberger

for the network, as well as a rich set of APIs, Benhamon explains. On top of that foundation, 3Com has added a number of features including electronic mail and internetworking services, support for Apple Computer Inc.'s Macintosh PCs, connections to mainframe computers, and network management services.

Microsoft is fully aware that the LAN Manager provides only a common foundation upon which to build, and the company is involved in other LAN-related development projects. One closely related to LAN Manager is the joint development with Hewlett-Packard Co. of the Microsoft LAN Manager/X (LM/X). This product will allow Unix System V-based computers to service requests from networked workstations running the OS/2 LAN Manager and other Microsoft system software. LM/X addresses the growing need of PC users to tap into the computational power and databases associated with computers running the Unix operating system.

Like 3Com, other OEMs will produce their own network systems based on LAN Manager, and these systems may differ greatly from 3Com's 3+Open in the range and sophistication of the features added to the Microsoft product. But applications software developed to run on any one of the LAN Manager networks should run equally well on all of them, says Benhamon, because they will share common communications protocols and applications interfaces.

Sophisticated products such as the 3+Open network operating system, not the foundation LAN Manager component, are what will compete directly with Novell's NetWare, explains William Becklean, vice president and telecommunications equipment analyst at the Boston offices of investment brokerage Kidder, Peabody & Co. "Although 3Com has done well in the hardware side of the business, it got a late start in the network operating system market," he says. "Building off of the OS/2 LAN Manager platform will give the company some potential to gain market share in that sector."

LAN Manager-based network op-

erating systems should compare favorably with NetWare because they permit the development of "distributed" applications software, claims Steve Kanzler, LAN Manager product manager at Microsoft. "The first generation of LANs permitted the sharing of expensive devices such as disk drives and laser printers," he says. "The second generation supported file sharing among networked computers, and NetWare represents the state-of-the-art of that generation.

Groupware

"The third generation, represented by LAN Manager, is the first to permit true distributed applications, or 'groupware,' over the network." Rather than the single-user applications that have been adapted for network use, distributed applications would make more efficient use of network resources and would permit groups of networked users to simultaneously work on common problems, Kanzler explains.

As a simple example of the advantages offered by distributed applications, 3Com's Benhamon notes that, when a PC user queries a centrally located database over most existing LANs, the entire database is shipped over the network to the user's workstation, which then runs the query application. A distributed database management application running on an LAN Manager network would, by contrast, permit the database server to run the query and just ship the results to the user's PC. This approach reduces network traffic and frees the PC workstation to perform other tasks.

Mark Calkins, vice president for marketing for the Novell Software Group, agrees that distributed applications are important, but he labels as "pure baloney" the claim that LAN Manager networks will be better able than NetWare to support such software. "There are no capabilities that LAN Manager networks can provide that we can't," he says. He also points out that distributed applications are nothing new, especially in the minicomputer networking world.

PC LANs have lagged, by contrast, because of the single-task nature of DOS-based computers. OS/2 machines, with their ability to run multiple programs at once, greatly improve the prospects for distributed networking applications over PC LANs, Calkins says, but he argues that LAN Manager networks will have no advantage over NetWare in this regard. Novell offers several products to support OS/2-based computers in the NetWare environment, and Calkins expresses no fear that the growing support for LAN Manager among OEMs and software houses will shift development activity away from the Novell system. Because of its broad market penetration, "No one developing applications will overlook NetWare," he believes.

Who's backing LAN manager

- Alcatel Information Systems
- Apollo Computer
- AT&T Information Systems
- Bull
- Compaq Computer
- NCR
- NEC
- Nixdorf
- Olivetti
- Siemens
- Tandem Computers
- Tandy
- Toshiba

Source: Microsoft Corp.

Walter Schramm, vice president for marketing at Gateway Communications Inc., an Irvine, California-based NetWare OEM, agrees. In addition, he points out, "It's too early to tell if LAN Manager will even hurt Netware. LAN Manager's success in the market will depend upon its performance and features relative to NetWare's, and [LAN Manager's] have yet to be proven."

Wild card

As a matter of fact, the view of some industry participants, LAN Manager could be a key factor in stimulating the nascent OS/2 marketplace. "LAN Manager is the first critical application out on OS/2," says Schramm at Gateway Communications. And Mike Barker, president of LAN vendor Micom-Interlan (a division of Micom Systems Inc. of Simi Valley, Calif.), believes the future availability of sophisticated applications developed for LAN Manager networks will boost demand for OS/2 machines. "OS/2 will ride the LAN Manager crest," he predicts.

One large wild card exists in this scenario, however: IBM. The computer giant will offer its own proprietary OS/2 networking product called LAN Server. Depending upon the information source, LAN Server is either virtually identical to the Microsoft OS/2 LAN Manager or is substantially different from it. For its part, IBM isn't talking — as usual. "We leave it up to the other vendors to announce compatibility with our products," says an IBM spokesman.

Should IBM's LAN Server differ appreciably from Microsoft's LAN Manager, the latter's attempts to generate broad-based OEM support could suffer greatly. However, major differences would also hurt IBM, analysts note, which can only benefit from the establishment of an OS/2 networking standard.

"IBM's primary goal continues to be the creation of increased cycle demand so that it can sell more computers," explains BRG's Myhre. "It can create that demand by providing compatibility between its LAN Server and the LAN Manager networks. This will encourage the development of higher level application programs, which will require the support of more powerful personal computers."

The same argument holds, however, for suggesting IBM's likely support of NetWare. "Applications running on NetWare will also stimulate demand for computers running OS/2," notes Novell's Calkins. He suggests that IBM has a multistandard networking strategy, and points out that Novell has worked closely with IBM on past projects. Analyst White agrees with the implication that IBM tacitly supports NetWare, saying, "There is no doubt that IBM considers Novell to be an ally."

As a result, most observers believe both NetWare and the LAN Manager networks will survive as standards in the LAN market. And, however the dust finally settles in this LAN turf battle, PC users can look forward to increased power and flexibility from their networked machines. "We need to be better able to take advantage of the intelligence of the network through distributed applications," concludes Microsoft's Kanzler, "so that the PC workstations don't have to do all the damn work alone."

DWIGHT DAVIS

OSI advocates interconnect to accelerate standards

Open System Interconnection enthusiasts join together to promote compatibility. Absent, however, are IBM and DEC

It seems like no cause is complete without a consortium and now, the ever-growing Open Systems Interconnection enthusiasts in the network management crowd can boast one as well. A group of eight computer and telecommunications companies — some of them rivals like AT&T and Northern Telecom Inc. — have banded together to smooth the way for development of network management tools that would adhere to OSI standards, and thus assure interconnectability of their products.

The group, called OSI/Network Management Forum, says that by agreeing on protocols and message sets from the myriad of options afforded by the seven-layer OSI, it will accelerate the development of compatible equipment by some two years. Industry observers are only cautiously optimistic, however, given the absence of certain network management movers and shakers like Digital Equipment Corp., IBM, Racal-Milgo, Codex and General Datacom.

They also point out that the formation of the consortium is not a move that will necessarily trigger breakneck growth in sales of OSI-based network management products. Rather, they see it as a logical step to combat industry giants IBM and DEC and their proprietary network and network management schemes.

Seven layers

Moreover, observers view it as a vehicle to whittle down to a workable size the massive standards encompassed under OSI, which according to proponent Jerry Foley, "could probably fill 10 file drawers." Foley is a senior engineer with Electronic Data Systems and chairman of the American National Standards Institute (ANSI) committee, responsible for defining OSI's upper three layers.

The OSI model defines seven layers of communications tasks that must be carried out to move data off one computer, through the network and onto another computer. At the top are the application, presentation and session layers. "They get traffic to the freeway on-ramp," according to the sponsors of the recent Enterprise Networking Event International in Baltimore, which was organized to promote OSI on the factory floor. The bottom layers — transport, network, data link and physical — "funnel traffic efficiently onto the freeway and off at the appropriate destination," explain the sponsors. At the receiving end, the same seven layers operate — in reverse order — to condition and format the data for storage or processing on another piece of equipment.

The forum introduced itself in midsummer, promising that member companies would demonstrate interoperable equipment in 18 months. Charter members, in addition to AT&T and Northern Telecom, are Amdahl Corp., British Telecommunications Plc, Hewlett-Packard Co., STC, Telecom Canada and Unisys Networks. Brian Hewat, a director of Telecom Canada, acknowledges that critical to the consortium's effectiveness will be its ability to "agree on a set of options within each of the seven layers of the OSI model."

A number of analysts are predicting the consortium will help forge alliances aimed at joint marketing of network and network management equipment, such as the Hewlett-Packard/Northern Telecom alliance — Corporate Networks Operation — formed earlier this year.

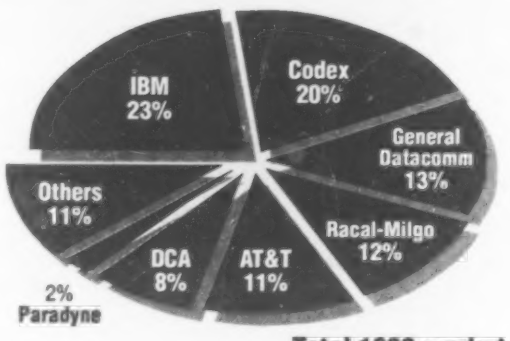
One company considering joining the group, Racal-Milgo, sees it as a vehicle "for making things happen" to bring uniformity to OSI and network management vendors, according to Bill Vasquez, product manager. Racal, he says, has been discussing possible strategic alliances with forum member AT&T, and with another prospective member, Digital Communications Associates Inc.

Still, there is the reality that some major players in network management have not carved their names into the OSI/NM Forum masthead. IBM, for one, has foregone membership, but says it will continue to review the possibility of joining. Its position reflects its stance in general. IBM has endorsed OSI, but has a much greater vested interest in its proprietary network management product, NetView, and its proprietary networking schemes — Systems Network Architecture and Systems Application Architecture. IBM will probably withhold from joining the group unless its OSI-based products begin to make major incursions on IBM market share in network management.

With or without the likes of IBM and Digital Equipment, the group must also figure out how to cooperate while many of them battle each other in the market. "It's sort of like an oil cartel, trying to address the pricing policy while competing," says Jeffrey Kaplan, an analyst with the Ledgeway Group in Boston. "Forum members are trying to develop common standards — while competing."

MARK HALPER

Network management market leaders



Total 1988 market
$3.3 billion

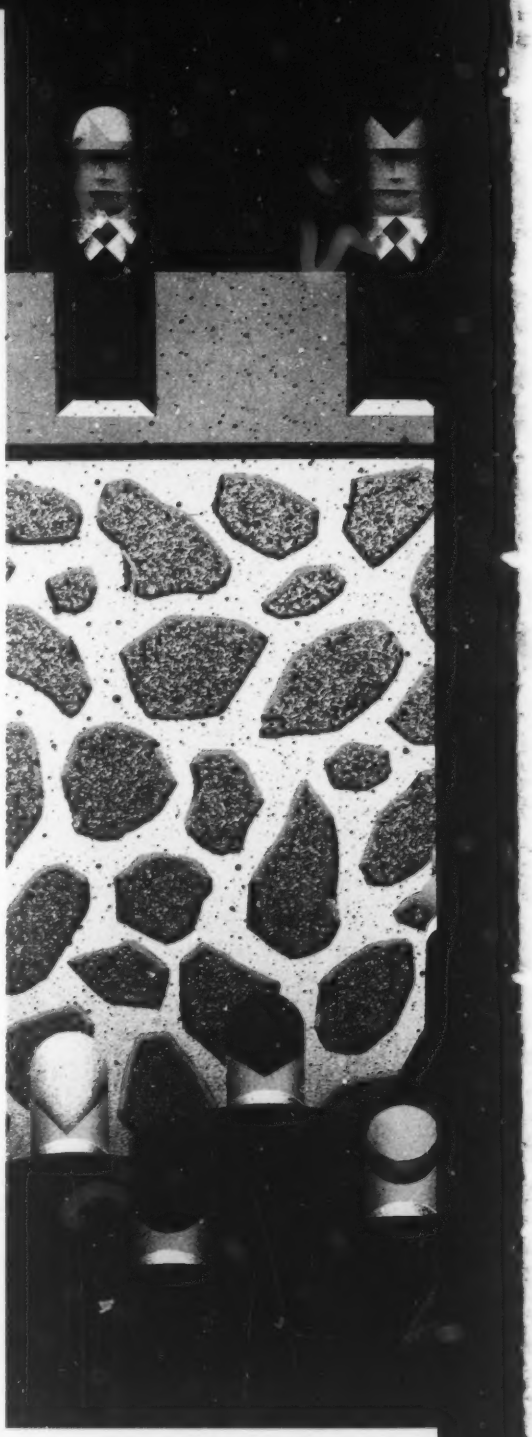
Source: International Technology Group

EC firms have embarked on international crusades to expand their influence. These campaigns could leave unprepared U.S. firms outside the kingdom gates.

Inside the fortress

Europe after 1992

BY SHERRY BUCHANAN



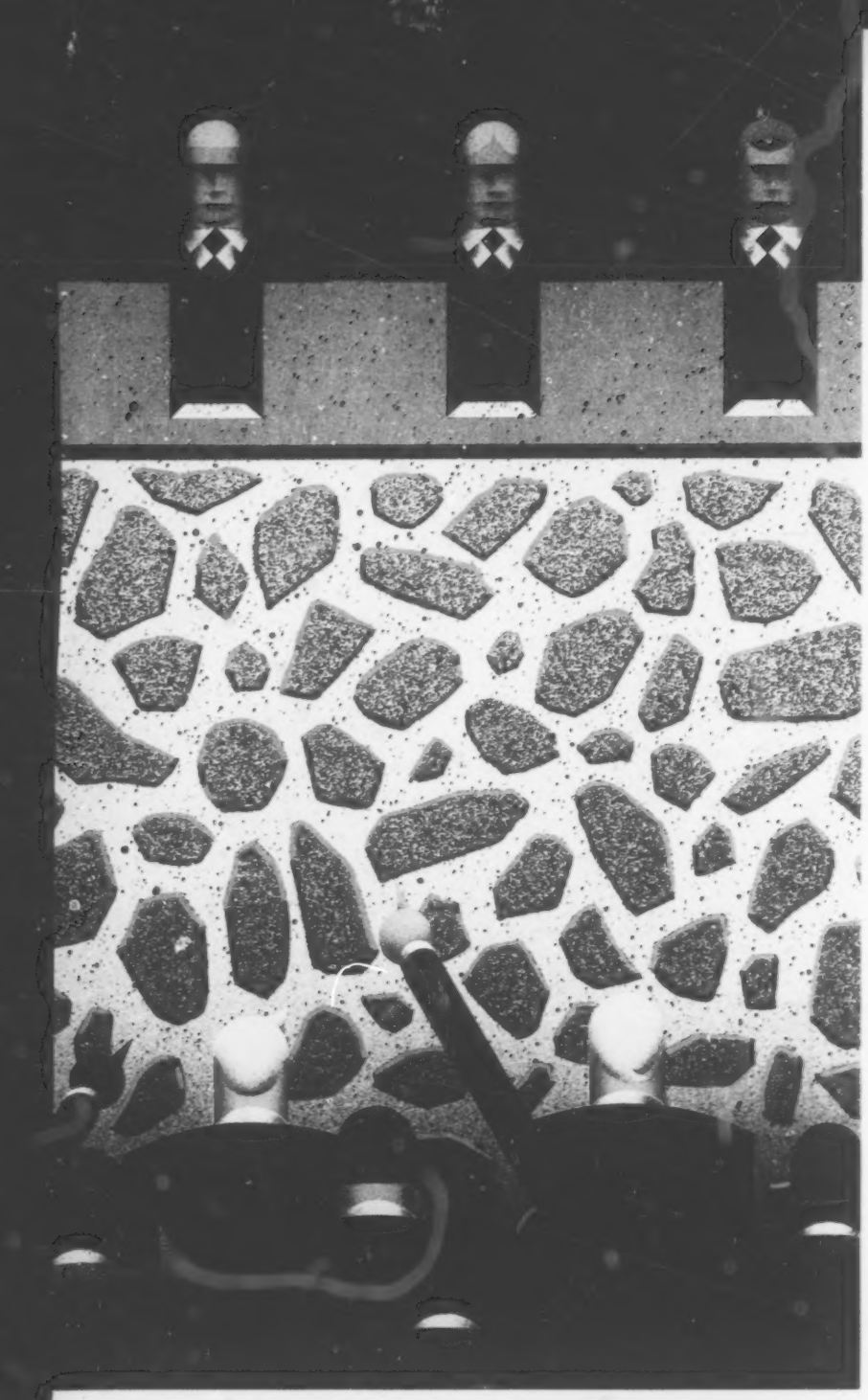
Europe's top electronics companies are scrambling to build global empires. They realize that they must expand volume to achieve the economies of scale necessary to finance high-technology growth. With some markets shrinking and competition from the United States and Japan increasing, those businesses that don't look beyond their borders will wind up as also-rans. "The globalization of the technologies and markets which fall within our sphere of operations calls for a worldwide approach to product policy," says C.J. van der Klugt, president of N.V. Philips GL of the Netherlands.

European firms will get a major boost in their international expansion plans in 1992, when the financial and trade barriers between countries are torn down. This will give EEC firms immediate access to a market with more people than the U.S. and about the same gross national product. With the so-called "United States of Europe" less than four years away, many companies have begun to stake out their claims in their expanding home territory.

Britain's The Plessey Company Plc, for example, has formed an International Development Group to, in the words of chairman Sir John Clark, "address urgently and vigorously the opportunities presented by this huge new market" and, like others, expand its ties with neighboring companies; in Plessey's case, Elettronica of Italy. "The year 1992 will be a watershed for industry throughout Europe," says Clark. "It will have profound effects on industrial companies."

But many Europeans worry that eliminating internal borders to allow free trade within the Common Market won't be enough. As a result, leading electronics companies may want to build higher walls to keep out non-European products. This worries Peter McPherson, deputy secretary of the U.S. Treasury Department, who is concerned that "an intensification of protectionism" could follow the restructuring.

At least some European firms are expected to lobby for tariffs, quotas and other trade restrictions to keep others out of the post-1992 Euromarket. Philips, for example, wants the EC action to block Japan from flooding the market with color televisions. Philips has scars from previous wars with the Japanese, notably in video cassette recorders. Philips virtually invented VCRs, but the Japanese came out with a competing standard and Philips had to toe their line. It's not all bad news for outsiders, though. Foreign companies located within the EC borders and those with European partners stand to benefit from the change to a Euromarket. (See related story in this issue on how



to do business in post-1992 Europe.)

In the accompanying tables, ELECTRONIC BUSINESS has ranked the top European electronics companies. This exclusive report is based on careful analysis of the financial statements of the largest companies doing business in Europe. Leading the list are Philips, IBM and Siemens. IBM Europe is consolidating its position as a strong, local company. Philips and Siemens are dramatically restructuring operations to survive in the changing marketplace.

Europe is not without its success stories. Still, much remains to be done if electronics companies want to make the most of the enlarged internal market. A controversial McKinsey & Co. report, published in July, compares British electronics companies with other European, U.S. and Japanese firms, and goes as far as saying that British electronics companies will not "survive" against Japanese, U.S. and some Western European competitors unless they radically change their current strategies.

The report criticizes Britain's electronics sector for relying too much on slow-growing defense and telecommunications business for revenue and also for not having expanded enough either in Europe or other international markets. "British electronics companies must invest to produce the critical mass necessary to be viable competitors in their chosen global markets," says Adair Turner, coauthor of the McKinsey report titled: "Performance and Competitive Success: Strengthening Competitiveness in the U.K. Electronics Industry."

The probability of a significant improvement in Britain's competitive performance — or even the survival of British electronics — looks dim unless major changes are made. The report, for instance, shows that, as a whole, British electronics companies have lost market share even in their home market. In 1976, they accounted for almost half of Britain's sales. By 1986, however, this figure had declined to less than a third.

International rivals

In addition to losing ground in their own home market, they haven't expanded internationally as much as their foreign rivals. As a result, in McKinsey's view, U.S., Japanese and some Western European companies — such as Philips, Thomson-CSF, L.M. Ericsson and Ing. C. Olivetti & Co. — are better prepared to take advantage of the new opportunities of the soon-to-be-borderless Europe. These companies already are present in many of the individual EC markets and have, or are building, management structures suited to running global organizations.

McKinsey argues that some big U.S., Japanese and other Western European companies already generate a larger proportion of their home sales outside their home markets and are truly global companies. Meanwhile, British electronics companies, other than perhaps Racal Electronics and British Aerospace Plc, have not taken a long-term approach and built up their international organizations.

Holland's Philips, for example, sells 93.3% abroad; America's Rank Xerox sells 84.3% outside its home market; Sweden's Ericsson, 78%; Japan's Sony Corp., 70.5%; Italy's Olivetti, 65.7%; and France's Thomson, 60%. Britain's two exceptions, British

Jose Cruz

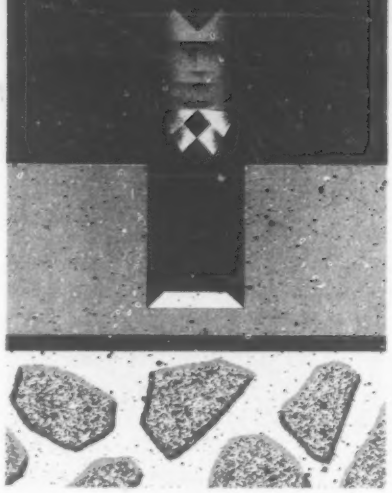
Aerospace and Racal, sell 66% and 60%, respectively, outside their home markets. Germany's giant Siemens AG, meanwhile, could take a lesson from others: It sells only 50% of its product in foreign markets. (Siemens is dramatically changing its strategy, see accompanying story.)

Doomsday scenario

London analysts do not all concur with McKinsey's doomsday scenario. In defense of British electronics companies' slow expansion into other EC countries, analysts point out it is a difficult task to find partners on the continent and that it takes time. "Europeans on the continent are very difficult to acquire," for example, says Miles Saltiel, electronics analyst with Hoare Govett, a London brokerage house. "You need long-term relationships and a lot of them have restricted share practices. A British company can't just go in there and do a hostile takeover."

At least one British firm targeted in the report's criticism, is currently reorganizing. Britain's General Electric Co. (GEC, no relation to the U.S. General Electric), which has operated with 120 independent subsidiaries, is centralizing control to ensure the convergence of new technologies. "So much of McKinsey's report seems to be aimed at GEC without specifically saying so," says Philip Hughes, chairman of Logica Plc, the British software house. "And the approach of having very decentralized development activities does make it very difficult to launch strategic initiatives."

Overpowering tough competitors abroad is proving a difficult task for some of the big European electronics companies —even those that are ahead of the game, relative to the British. Price pressures in the consumer electronics sector and competition from low-cost producers such as the Koreans have forced the major European companies to merge or be acquired. Last year, England's Plessey and GEC combined their strengths in telecommunications; Plessey expanded its stake in Elettronica to 49%; and Sweden's Asea AB and West Germany's BBC Brown Boveri merged the worldwide electrical engineering activity. It is essential "to utilize the global economies of scale" and focus on "growth ambitions in Europe and transoceanic countries," according to Percy



"The restructuring of the European market could possibly lead to an intensification of protectionism"

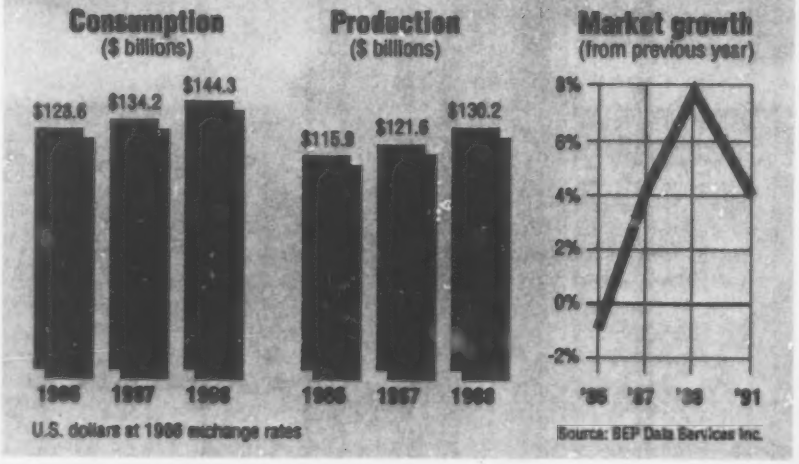
Barnevik, Asea president and CEO.

Meanwhile, Philips, which employs 340,000 worldwide, is facing the difficult task of going through a massive internal reorganization to cut costs by 800 million guilders (or $374 million — in late August, 2.14 guilders = $1) this year. In Europe, Philips says it will cut middle management by 20,000 people. During the next five to 10 years, it will close 70 European plants. Philips has already laid off 6,000 European employees and expects between 4,000 and 14,000 more job losses. Like GEC, Philips in the past relied on fiercely independent national subsidiaries. As part of the move to tighten control over national organizations, Philips has just named Geerit Jeelof, formerly vice chairman of the board of management, to head its U.S. operation.

"Philips is a microcosm of the whole industry and a very good indicator of what's going on in other places," says Angela Dean, analyst at Robert Fleming Securities Ltd., a London brokerage house. For example, at the end of July, Philips' second quarter net profit plunged 44%, an unexpectedly poor showing which sent stock down. Many analysts had expected Philips' earnings to be about equal to last year's, at 818 million guilders, or $382 million. Philips is Western Europe's biggest maker of semiconductors and consumer electronics products. Turnover has fallen steadily since 1985 and profit margins in the 1980s are not what they were in the 1960s.

"Our major task is to find an answer to what is the most pressing problem in consumer electronics, and that is constant price erosion," says Jan Timmer, Philips board member responsible for consumer electronics. "We have two to three years to know whether Philips will be able to make it in consumer electronics." Philips blames Japanese and Korean dumping. But, contends Pat Meagher-Davis, European electronics analyst with James Capel and Company, in London: "Antidumping measures

European electronics industry



U.S. dollars at 1988 exchange rates

Source: BEP Data Services Inc.

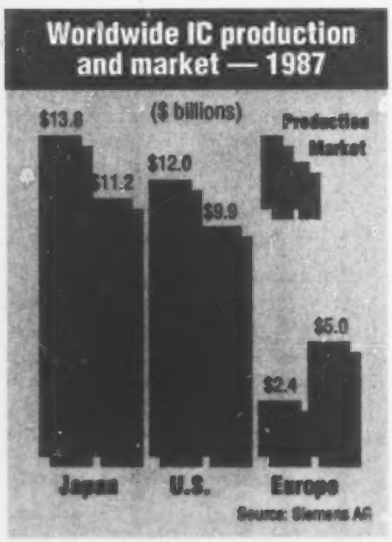
wouldn't solve the problem, it would only buy them time."

Philips, meanwhile, is rationalizing production, closing European plants and transferring manufacturing to the Far East. Executives say this shift will continue. Philips says survival depends on taking advantage of economies of scale and becoming a low-cost producer. The Dutch giant already has 27,000 employees and 25 plants in Japan, Hong Kong and other Asian countries and plans to shift more production there, as well as to Mexico. In Asia, Philips already manufactures black-and-white televisions, radios and video cassette recorders, which it sells worldwide. Philips also has plans to expand product development and engineering activities in the Far East.

Computer firms hold out

Despite this flurry of activity around the world, the majority of European computer makers are staying closer to home for the time being, although some of the larger players like Siemens are likely to increase their size and expand in European markets and, eventually, the United States. Others, like West Germany's Nixdorf Computer AG are, however, eyeing the world markets — with some success.

"It is going to get very hot in the computer sector, where not much restructuring has happened yet, and life is quite difficult," says Dean of Robert Fleming. "Too many companies are competing in a market that



The post-1992 Euromarket will have more people than the U.S. and about the same gross national product

is dominated by United States suppliers. [illegible] computer companies remain strong market leaders in the European market, according to Dataquest. IBM has 56% of the European market in corporate resource computers (computers which cost more than $1 million). Digital Equipment Corp. is the leader in business unit computers with 20% of the European market (computers which cost between $75,000 and $250,000).

Eventually, industry observers say, European computer companies will reorganize through mergers and acquisitions. Margins are being squeezed, market growth has slowed and most European companies are small relative to the giant United States firms. "We will see a lot of M&A activity — especially between hardware and software companies," says Meagher-Davis. "And a lot of those companies are cheap."

According to Meagher-Davis, European companies should be well placed to take advantage of what she calls the " 'microcomputer application.' You can't sell people just a box anymore, you have to sell them the total solution," she says. "Unlike the U.S. companies, European companies — Nixdorf is a prime example — have grown up that way." Some consolidation has already taken place between suppliers of hardware.

In January of last year, Siemens and BASF combined their IBM-compatible mainframe businesses to create Comparex, with sales of $500 million. And in March 1987, France's Groupe Bull, the United States' Honeywell Inc. and Japan's NEC Corp. created an organization with sales worth $2.1 billion. Britain's STC, which bought ICL, the British computer company, is currently looking for software houses to buy in West Germany.

As European companies restructure to secure their soon-to-be-expanded European home market, analysts also predict they will become more active in the U.S. market. In July, Siemens, the German electronics concern, signed an agreement to acquire a majority interest in Allied-Signal Inc.'s Bendix automotive electronics group for some $250 million. In the last few months, Siemens has set up ventures with Intel Corp. in microcomputers; Advanced Micro Devices Inc. in telecommunications and semiconductors; and Westinghouse Electric Corp. in factory automation and industrial controls.

According to analysts, there have been few moves by either U.S. or Japanese companies to acquire European firms. The United States' General Electric Co. did, however, take on Thomson-CGR, Thomson's medical systems business, as part of a deal whereby Thomson acquired GE's consumer electronics business. "If you look at computers and consumer electronics, the U.S. and Japanese companies are already significant competitors. The fight will be in public telecommunications. I don't think the European companies are badly placed," says Dean. "It suddenly may look a lot easier to the U.S. and Japanese companies to come into a big market, the European internal market. But there are opportunities on both sides."

The success story on everyone's mind is Ericsson. "For really good companies, the liberalization of telecommunications buying practices and the impending advent of 1992 will be a challenge," says Dean. "Just look what Ericsson did. It realized it couldn't survive in just Sweden, so it took advantage of the opening of the world telecommunications markets." Ericsson, which was an early leader in public switching systems, has captured 40% of the world cellular radio market. Others dream of similar success stories. □

Top European electronics companies

Rank	Company	Electronics sales ($ millions)	Electronics sales as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$18,825	72%	$25,968	1.9%	1.5%	$77,125	$1,488
2	**IBM**	18,332	34%	54,217	15.9%	9.7%	139,251	22,111
3	**Siemens**	15,098	55%	27,503	5.1%	2.5%	76,611	3,870
4	**CGE**	12,770	60%	21,208	3.9%	2.5%	96,620	3,808
5	**Thomson-CSF**	5,970	100%	5,970	10.4%	7.3%	NA	NA
6	**GEC**	5,756	61%	9,457	12.7%	8.1%	60,136	7,667
7	**Olivetti**	5,121	90%	5,688	7.3%	5.5%	NA	NA
8	**Ericsson**	4,238	83%	5,102	3.4%	2.3%	71,973	2,461
9	**Robert Bosch**	3,954	28%	14,092	6.9%	3.3%	87,340	5,987
10	**Xerox**	3,325	32%	10,320	8.1%	5.6%	104,209	8,482
11	**DEC**	3,253	35%	9,389	18.0%	12.1%	84,972	15,284
12	**STC**	3,147	93%	3,388	9.1%	6.0%	97,054	8,829
13	**STET**	3,113	26%	11,972	9.3%	7.2%	96,315	8,947
14	**Nixdorf**	2,817	100%	2,817	6.5%	5.2%	95,687	6,238
15	**British Telecom**	2,805	16%	17,346	22.5%	14.3%	73,125	16,456
16	**Hewlett-Packard**	2,667	33%	8,090	11.9%	8.0%	98,659	11,732
17	**Unisys**	2,400	25%	9,713	9.8%	6.0%	105,004	10,243
18	**AEG**	2,333	36%	6,478	0.7%	0.0%	80,972	576
19	**Sony**	2,290	22%	10,347	5.1%	2.6%	171,025	8,783
20	**Matsushita**	2,233	6%	34,839	8.9%	3.4%	259,632	23,232
21	**Plessey**	2,216	100%	2,216	13.2%	9.1%	73,512	9,725
22	**Racal**	2,113	91%	2,328	10.1%	6.6%	72,970	7,370
23	**Canon**	2,058	30%	6,753	4.1%	1.4%	179,984	7,415
24	**NCR**	1,797	32%	5,641	13.5%	7.4%	90,979	12,297
25	**Nokia**	1,499	47%	3,174	9.0%	6.0%	NA	NA
26	**Grundig**	1,524	100%	1,524	4.9%	3.5%	78,241	3,844
27	**Thorn EMI**	1,352	26%	5,201	7.4%	4.8%	81,268	5,995
28	**Schlumberger**	1,300	30%	4,402	14.1%	11.4%	88,040	12,371
29	**Motorola**	1,200	18%	6,707	6.2%	4.6%	68,649	4,258
30	**Ferranti**	1,121	80%	1,400	8.3%	5.6%	56,414	4,666
31	**Control Data**	1,119	33%	3,367	1.7%	0.7%	97,580	1,664
32	**Bayer**	1,111	5%	20,635	8.3%	4.2%	125,517	10,361
33	**Mannesmann**	1,083	12%	9,253	1.7%	0.8%	81,685	1,365
34	**Honeywell**	1,005	15%	6,679	6.2%	3.8%	84,676	5,222
35	**Fiat Group**	928	3%	29,384	NA	NA	107,047	NA

NA = Not available

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information have been converted to dollars using an exchange rate that consists of the average rate during each company's fiscal year.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe; for non-European companies the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$1,182	$27,048	16.0%	3.2%	8.3%	7.7%	1.49	12/87	Netherlands
13,505	58,873	18.0%	17.1%	10.0%	7.9%	2.32	12/87	U.S.
1,900	19,989	21.3%	5.9%	12.1%	9.2%	3.73	9/87	West Germany
2,367	14,624	11.7%	7.5%	7.8%	3.9%	1.28	12/87	France
NA	NA	NA	NA	NA	NA	NA	12/87	France
4,882	8,930	17.1%	20.8%	12.1%	5.0%	2.11	3/88	Britain
NA	NA	NA	NA	0.7%	NA	NA	12/87	Italy
1,633	15,057	14.8%	5.2%	9.9%	4.9%	2.02	12/87	Sweden
2,839	13,905	13.6%	18.0%	5.6%	7.9%	2.08	12/87	West Germany
5,836	25,416	16.1%	11.0%	7.0%	9.1%	1.56	12/87	U.S.
10,293	19,252	18.7%	26.0%	10.8%	8.0%	3.40	6/87	U.S.
5,809	15,582	14.2%	25.0%	8.5%	5.7%	1.70	12/87	Britain
6,931	191,272	NA	NA	NA	35.8%	NA	12/87	Italy
4,985	29,278	23.4%	9.7%	9.4%	14.0%	2.36	12/87	West Germany
10,475	87,234	25.1%	19.4%	1.9%	23.2%	0.90	3/88	Britain
7,854	28,390	17.4%	18.9%	11.1%	6.3%	2.01	10/87	U.S.
6,249	22,929	13.6%	24.3%	6.1%	7.4%	1.33	12/87	U.S.
0	12,354	13.3%	1.3%	8.0%	5.4%	4.38	12/87	West Germany
4,390	50,942	18.2%	10.7%	8.9%	9.3%	1.14	3/88	Japan
8,773	29,301	9.3%	12.9%	5.6%	3.6%	2.15	3/88	Japan
6,708	13,528	12.6%	21.4%	7.2%	5.3%	1.50	3/88	Britain
4,781	20,367	9.8%	19.3%	NA	9.8%	1.53	3/88	Britain
2,441	43,606	12.3%	6.6%	5.8%	6.5%	1.73	12/87	Japan
6,763	17,068	13.2%	33.7%	6.3%	6.9%	1.72	12/87	U.S.
NA	NA	NA	NA	NA	NA	NA	12/87	Finland
2,751	10,686	9.9%	19.9%	3.4%	6.5%	1.25	3/87	West Germany
3,893	24,828	14.2%	21.1%	1.1%	13.1%	1.09	3/88	Britain
10,051	33,407	14.3%	15.1%	8.0%	6.3%	1.66	12/87	Netherlands Antilles
3,153	23,838	17.6%	12.4%	7.8%	9.8%	1.62	12/87	U.S.
3,136	17,094	10.1%	15.6%	4.9%	5.2%	1.31	3/88	Britain
722	17,675	16.9%	4.3%	11.6%	5.3%	1.63	12/87	U.S.
5,218	34,962	13.1%	24.1%	6.2%	6.9%	1.26	12/87	West Germany
656	19,785	6.2%	4.0%	2.2%	4.0%	1.42	12/87	West Germany
3,216	17,454	9.0%	18.0%	4.3%	4.7%	1.24	12/87	U.S.
NA	NA	NA	11.9%	3.5%	8.4%	NA	12/87	Italy

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investment (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country or origin: Indicates the country in which the company is ultimately registered.

Source: ELECTRONIC BUSINESS

Power pay: How the big guys made even more money

The 100 highest-paid electronics executives had to put up with a 23% raise last year. Their average take-home? Just $780,000

BY TONY GREENE

Most of us fret about how we're going to make ends meet on our inflation-pacing salary increments. But not the top executives in the U.S. electronics industry. The 100 highest-paid are plagued instead by the nightmare of how to spend their 23% raise.

According to a new survey by ELECTRONIC BUSINESS, the average paycheck for the top-paid 100 electronics executives rose $149,094 in 1987, or 23.5% over the past year, making for an average *weekly* compensation of $15,100.

And ELECTRONIC BUSINESS' "million-dollar club" boosted its membership dramatically as the ranks of those bringing home seven-figure compensation rose from six to 17. Disk-drive maker Seagate Technology Inc. claimed the honor of having the most new members initiated into the club, bringing three new names to the list.

The big winners were computer company executives, with over 50% of this year's highest-paid 100 coming from computer, peripherals or software companies. Also, with the exception of Xerox Corp. and Advanced Micro Devices Inc., all the members of the million-dollar club came from this same group.

One of the major reasons for the boost to top executive compensation is the increased profitability of the electronics industry in 1987. The recent ELECTRONIC BUSINESS 200 survey found that sales for the top 200 U.S. electronics companies were up 7.4%, while profitability climbed 53.6% [ELECTRONIC BUSINESS July 15, 1988 p26]. This translates into dollar signs for executives whose salaries and bonuses are normally tied to the performance of the company.

While cash is still king in the world of executive compensation, there are other factors that top staffers are beginning to look for. Research by ELECTRONIC BUSINESS reveals several distinct trends:

- Contracts, which have not been prevalent until recently, are becoming more popular. This is believed to be mainly in response to executives' need for a feeling of security in today's volatile mergers-and-acquisitions world.
- As the industry matures, companies are looking for older, more seasoned executives to head companies. But "mature" is a relative term; and senior executives in the electronics industry still tend to be younger than execs in other industries.

The bottom line for the electronics industry's highest-paid execs: Cash is still king

- Perquisites such as company houses and cars, while still nice, are not the incentive they used to be under the new tax laws. Executives and their recruiters are holding their breath to see what the coming year will bring in the area of taxes.
- Executive recruiters see a shortage of qualified upper level executives in the future of the electronics industry — a shortage that will make compensation a critical factor as companies strive to get and keep top level people.

Seagate is one company that should not have to worry about keeping its execs. The disk-drive maker boasts three chiefs in the ELECTRONIC BUSINESS power-pay club — David T. Mitchell, president and COO; Douglas K. Mahon, senior vice president and chief technical officer; and Alan F. Shugart, chairman of the board and CEO. And it places two other executives in the top 100, putting all five of their top-paid executives on the rolls.

Seagate's top trio experienced an average increase of 209.2% — compensation that came as a direct response to the company's performance in 1986 and 1987. Seagate declined to comment on whether salaries this year would show a corresponding decrease as the company reported a fall in net income of 56% in the fourth quarter of fiscal 1988, ended June 30.

In addition to Seagate, Apple Computer Inc., Compaq Computer Corp. and Unisys Corp. all put five executives in the top 100. John Sculley, Apple's president and CEO, leads this year's list with a modest increase of 26.1% to $2,140,000. The No. 2 on ELECTRONIC BUSINESS' top-pay list, W. Michael Blumenthal, chairman and CEO of Unisys Corp., is the only person in the top five to show a decrease: 28.8% down from 1986 to give him cash compensation of $1,549,440.

Honeywell Inc.'s top paid executives — Edson W. Spenser, chairman and CEO; and James J. Renier, president and COO — provide a good example of how executive compensation can be tied to profitability. Both men experienced reductions in their cash compensation in 1986 [ELECTRONIC BUSINESS Oct. 15, 1987 p52] when Honywell reported a loss of $389 million. In fact, in 1987, when the company showed net income of $254 million, Spenser and Renier had an average increase of 88.5%. A spokesperson for Honeywell says that executive compensation is tied to three factors: the company's earn-

The men with the megabucks: Apple Computer chairman John Sculley, $2,140,000; Unisys chairman Michael Blumenthal, $1,549,440; Computer Associates CEO Charles Wang, $1,431,000; Compaq Computer president Joseph "Rod" Canion, $1,375,000; and Seagate Technology president David "Tom" Mitchell, $1,354,975

Dorothy Ahle

ings, return on investment and return on equity.

Executive salaries have risen strongly throughout the electronics industry. A recent survey by the American Electronics Association shows that last year, executive salaries posted their largest average increase — 7.5% — since 1984. This is up more than 2% from the previous year. This is still not as high, though, as the average increase for top executives in all industries. Jill Kanin-Lovers, an associate at Towers, Perrin, Forster and Crosby, a New York City-based consulting firm that specializes in executive compensation, says that according to their survey, senior benchmark salaries rose an average of 12% in 1988.

Sign here, please

Although salaries are going up and business is good, many executives are edgy about their security and are asking for contracts. Alan Glou, president of Needham, Massachusetts-based Glou International Inc., an executive search firm that specializes in the electronics industry, says, "They're looking for security with companies that have the ability to be acquired." What most of the contracts amount to is a guarantee of severance pay — a buy-out clause — if the company is acquired. Chris Blake, president of San Jose executive search firm Robert S. Blake Associates Inc., says, "There is no security in the electronics industry —only opportunity."

Another factor that is going to be figuring into executive compensation is the law of supply and demand. "There is a shortage of seasoned, qualified people at the upper executive level," says James W. Furlong, president of Van Nuys, California-based executive search firm Furlong-Gates. As the industry matures, there is a greater need for experienced top level management that will give executives leverage to demand greater cash compensation in the future.

One of the problems is the general feeling — Sculley's crossover from PepsiCo Inc. to Apple notwithstanding — that executives from other industries cannot run electronics concerns. Gene Spence, a partner at the executive search firm Heidrick and Struggles Inc., which placed Sculley at Apple, says, "Sculley is the exception, not the norm."

The bottom line is that cash is still king. Perquisites such as company houses and cars are not as popular as they once were because thay are currently taxed like cash, so senior staffers feel they may as well settle for cash in the first place. But, while cash may be king, stock options are not dead. They are still a major part of any upper-level compensation package. The increase in cash is in addition to, not instead of, stock options. This is even true of executives going to start-ups and venture capital-backed firms. "Gone are the days when executives will take a hit to go to a venture-funded company," says Spence. □

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
1	John Sculley/48	$2,140,000	26.1%	Apple Computer	Chairman, president, CEO
2	W. Michael Blumenthal/62	1,549,440	-28.8%	Unisys	Chairman, CEO
3	Charles B. Wang/43	1,431,000	NA	Computer Associates	CEO, chairman
4	Joseph R. Canion/42	1,375,000	150.0%	Compaq Computer	President, CEO, director
5	David T. Mitchell/45	1,354,975	193.2%	Seagate Technology	President, COO
6	Douglas K. Mahon	1,274,120	210.4%	Seagate Technology	Senior VP, chief technical officer
7	Alan F. Shugart/56	1,263,951	223.9%	Seagate Technology	Chairman, CEO
8	Paul G. Stern/48[1]	1,195,920	43.4%	Unisys	President
9	John A. Young/55	1,193,300	29.8%	Hewlett-Packard	President, CEO, chairman
10	Anthony W. Wang/45	1,188,000	NA	Computer Associates	President, COO, director
11	David T. Kearns/57	1,165,465	33.2%	Xerox	Chairman, CEO
12	W.J. Sanders III/51	1,057,080	121.6%	Advanced Micro Devices	Chairman, CEO
13	Joseph J. Kroger	1,029,337	NA	Unisys	Vice chairman
14	Fred W. O'Green/66	1,022,510	NA	Litton Industries	Chairman, director
15	Edson W. Spenser/61	1,014,185	80.5%	Honeywell	Chairman, director
16	Charles E. Exley Jr./58	1,001,200	6.7%	NCR	Chairman, CEO
17	Paul C. Ely Jr./56	1,000,000	-15.9%	Convergent	Chairman
18	Jim P. Manzi/36	940,872	18.4%	Lotus	President, chairman, director
19	John V. Roach/48	916,240	50.5%	Tandy	Chairman, CEO, president
20	Kenneth H. Olsen/61	905,706	20.0%	Digital Equipment	President, CEO
21	Thomas P. Howes[2]	901,000	NA	Esterline	President
22	John C. Lewis/52	898,013	8.1%	Amdahl	Chairman, CEO
23	Robert M. Price/57	885,858	7.0%	Control Data	Chairman, president, CEO
24	Melvin Howard/53	875,952	24.5%	Xerox	Vice chairman, subsidiary officer
25	Edward M. Esber, Jr./35	874,086	-7.3%	Ashton Tate	Chairman, CEO
26	James J. Renier/58	861,256	96.5%	Honeywell	President, COO, CEO, director
27	John F. Akers/53	840,896	18.1%	IBM	Chairman
28	David R. Tacke/65	837,319	22.2%	E-Systems	Chairman, CEO
29	Delbert W. Yocam	832,000	69.2%	Apple Computer	Executive VP, COO
30	John F. Cunningham/45	831,664	NA	Computer Consoles	Chairman, president, CEO
31	Jean-Louis Gassee	831,000	148.5%	Apple Computer	VP product development
32	Eckhard Pfeiffer/45	827,965	176.0%	Compaq Computer	Senior VP international
33	Stephen L. Lane/51	827,500	NA	Emerson Radio	President
34	William W. Lane/53	827,500	NA	Emerson Radio	Chairman
35	John T. Hartley/57	819,578	30.0%	Harris	President, CEO
36	Anthony R. Hamiliton/63	814,668	14.3%	Avnet	Chairman, CEO
37	Leon Machiz/63	814,668	14.3%	Avnet	Vice chairman, COO, president
38	William F. Glavin/56	800,014	37.6%	Xerox	Vice chairman
39	Frank G. Hickey/60	797,767	79.8%	General Instrument	Chairman, CEO
40	James A. Unruh/46[1]	795,961	73.3%	Unisys	Executive VP
41	George B. Harvey/56	794,093	-28.0%	Pitney Bowes	Chairman, president, CEO
42	Orion L. Hoch/58	782,621	NA	Litton Industries	President, CEO, director
43	Donald L. Waite	762,303	191.1%	Seagate Technology	Senior VP, CFO
44	William F. Schmied/59	756,933	28.3%	Singer	President, COO
45	Dean O. Morton/55	750,121	29.6%	Hewlett-Packard	Executive VP, COO, director
46	William J. Weisz/60	746,170	27.1%	Motorola	Vice chairman
47	Joe M. Henson/54	737,857	7.9%	Prime Computer	President, CEO, director
48	Lawrence J. Ellison/43	711,875	NA	Oracle	President
49	Paul A. Allaire/49	709,119	49.3%	Xerox	President
50	Michael H. Spindler	709,000	47.6%	Apple Computer	Senior VP, int'l sales & marketing

[1] resigned Dec. 31, 1987
[2] resigned
NA = Not available

(Continued)

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
51	**Norbert R. Berg/56**	$707,940	5.2%	Control Data	Deputy chairman
52	**Andrew S. Grove/51**	697,011	92.5%	Intel	President, COO
53	**Bertil D. Nordin/53**[3]	686,077	85.5%	Digital Communications	President, chairman, CEO
54	**Sidney Topol/62**	685,995	76.6%	Scientific-Atlanta	Chairman
55	**C. Peter McColough/65**	685,310	23.8%	Xerox	Chairman executive committee
56	**Jerry R. Junkins/50**	685,000	37.0%	Texas Instruments	President, CEO
57	**Gordon E. Moore/59**	684,419	85.7%	Intel	Chairman
58	**Eugene R. White/56**	682,915	8.7%	Amdahl	Vice president
59	**John F. Mitchell/59**	679,575	33.2%	Motorola	President, director
60	**Marshall D. Butler/61**	679,000	175.7%	AVX	Chairman
61	**James L. Donald/55**	678,574	75.2%	DSC Communications	President, CEO
62	**Harold Falik/37**	678,100	NA	Emerson Radio	Senior VP
63	**Stanley A. Wainer/61**	670,000	21.8%	Wyle Laboratories	Chairman, CEO
64	**K.V. Cassani/59**	667,231	NA	IBM	Vice chairman
65	**Mark Shepherd Jr./65**	660,020	43.5%	Texas Instruments	Chairman
66	**Bernard S. Appel**	659,673	44.1%	Tandy	President Radio Shack div.
67	**Jack D. Kuehler/55**	656,126	23.5%	IBM	Vice chairman
68	**Thomas A. Vanderslice/56**	650,190	NA	Apollo	Chairman, CEO
69	**John F. Gribi/45**	650,000	140.7%	Compaq Computer	Senior VP finance, CFO
70	**Luther Nussbaum/45**	641,922	82.1%	Ashton-Tate	President, COO
71	**Albert A. Eisenstat/57**	640,000	60.8%	Apple Computer	Sr. VP, general counsel, secretary
72	**Frank A. Brand/63**	627,500	141.3%	M/A-COM	Senior VP, chief technical officer
73	**William G. Moore Jr./48**	624,077	-29.6%	Recognition Equipment	Chairman, president, CEO
74	**Sing C. Tien**	615,470	NA	Seagate Technology	Senior VP, Far East operations
75	**E. Joseph Zemke/47**	604,987	19.4%	Amdahl	President, COO, director
76	**Robert W. Galvin/65**	600,000	10.5%	Motorola	Chairman
77	**Michael S. Swavely**	600,000	NA	Compaq Computer	VP, sales & marketing
78	**Thomas F. Burke/58**	600,000	160.9%	M/A-COM	President, CEO, COO
79	**Frederick A. Krehbiel/45**	575,546	95.1%	Molex	Executive VP, president Molex Int'l
80	**Winston R. Wallin/62**	569,498	0.6%	Medtronic	Chairman, president, CEO
81	**John A. Rollwagen/47**	564,877	-9.2%	Cray Research	Chairman, CEO
82	**James F. McDonald/48**	559,225	-14.5%	Gould	Chairman, president, CEO
83	**A.J. Krowe/55**	557,408	NA	IBM	Executive VP
84	**James M. Eckhart/56**	555,000	96.6%	Compaq Computer	Senior VP corporate operations
85	**David A. Bossen/61**	543,000	6.7%	Measurex	President, CEO, director
86	**Roger W. Johnson/53**	542,375	23.2%	Western Digital	Chairman, president, CEO
87	**Walter F. Raab/63**	541,000	9.7%	AMP	Chairman, CEO, director
88	**George M. Scalise/54**	538,418	NA	Maxtor	President, CEO
89	**Donald J. Atwood/64**	538,000	NA	General Motors	President GM Hughes Electronics
90	**Donald Dvorkin/44**	537,500	NA	Emerson Radio	Executive VP
91	**Joseph T. Casey/56**	535,056	NA	Litton Industries	Executive VP, CFO, director
92	**William E. Terry/54**	533,013	24.4%	Hewlett-Packard	Executive VP, director
93	**Hollis L. Caswell**	527,140	NA	Unisys	Senior VP
94	**Charles M. Clough/59**	520,000	4.0%	Wyle Laboratories	President, COO
95	**Leslie L. Vadasz/51**	519,774	84.0%	Intel	Senior VP
96	**William E. Johnson/46**	514,482	NA	Scientific-Atlanta	Vice chairman, CEO
97	**James G. Treybig/47**	513,405	47.7%	Tandem Computers	President, CEO, director
98	**John J. Shields/57**	512,233	26.5%	Digital Equipment	Senior VP
99	**John F. Smith/52**	511,114	26.2%	Digital Equipment	Senior VP
100	**Joseph F. Caligiuri**	508,698	NA	Litton Industries	Executive VP

[3] became chairman April 1987, resigned as president
NA = Not available

Source: ELECTRONIC BUSINESS

ASIC strategies for the Big Five

The big five U.S. chip makers — TI, Motorola, Intel, National and AMD — have each developed a unique approach to the ASIC market

BY MICHAEL R. LEIBOWITZ

Until recently, conventional wisdom held that the "big five" U.S. chip makers had to become big players in a new business, and they had to do it fast. Application-specific integrated circuits were about to take over the integrated circuit business just as surely as ICs took over the transistor business in the 1970s. Equipment makers the world over were eliminating standard logic parts from new designs in favor of a few customized chips — ASICs — that incorporate much of the circuitry. In light of this, the warning to the big five was clear: Bring on ASIC capability or watch your businesses crumble.

Well, in case you haven't noticed, the top U.S. chip makers — Advanced Micro Devices Inc., Intel Corp., Motorola Inc., National Semiconductor Corp. and Texas Instruments Inc. — are doing quite well today without ASICs as a significant portion of their businesses. According to Scottsdale, Arizona-based Integrated Circuit Engineering Corp. (ICE), most of the five largest will have ASIC sales amounting to less than 4% of their total IC sales this year. "The major guys haven't been successful in ASICs," observes William McClean, an analyst with ICE. Despite this, they are enjoying a boom to rival any of the past booms.

Prosperity has brought a sigh of relief from the major U.S. chip makers — and the realization that, at least for the time being, they can indeed survive and thrive without ASICs. Wall Street, with its eye on profits, couldn't care less about the big chip makers' lack of success in ASICs. "It's not going to change earnings, perceptions or anyone's regard for a company in the next year or two," says Jack Geraghty, an analyst with First Boston Corp. Adds Michael Gumport, an analyst with Drexel Burnham Lambert Inc.: "ASICs are a niche in the overall scheme of things."

And with the pressure to become overnight ASIC leaders subsiding, chip makers are taking the hint. Within the last six months, both Intel and Motorola have closed their stand-alone ASIC operations. And Intel says it will end all gate array efforts. "We have shifted our focus," says Dave House, Intel's senior vice president and MCG general manager, explaining how the company is reallocating the resources necessary to build up a business in ASICs. "We're taking a fairly long-term view of this."

From interviews with each of the big five it is clear that no chip maker is abandoning its ASIC efforts. Each says it is continuing to develop ASIC tools and broaden ASIC capabilities. But gone is the urgency to offer ASICs to a broad cross-section of the customer base overnight — and the need to commit the great resources necessary to achieve this. The emphasis is now on supporting custom needs of the chip makers' biggest customers — the Fords and the General Motors, for example — the 20% or less that represent 80% or more of their business. And these will be the main beneficiaries of chip makers' ASIC activities over the next three years. The ability to support the ASIC needs of a wider swath of customers will occur gradually — sometime in the 1990s.

Several years ago, it was understandable to assume that chip makers would quickly have to play a major role in ASICs. After all, the business that was made possible by the advent of computer-aided design

Texas Instruments' Rhines: TI has aggressively built up a standard cell business

software in the early 1980s was growing by leaps and bounds. In 1984, three years after gate array pioneer LSI Logic Corp. shipped its first parts, ASIC makers shipped $920 million worth of parts in two main categories of ASICs, gate array and standard cell chips, according to ICE.

The main participants — ASIC houses such as LSI Logic, VLSI Technology Inc., NCR Microelectronics and a newly descended swarm of Japanese ASIC players such as Fujitsu Ltd., Toshiba Corp. and NEC Corp. — promised to make ASICs a big business. And they backed it by the capability to quickly turn around ASIC designs, excellent software tools and good support. Analysts, enthused by the prospect of an ASIC revolution, projected a $10 billion market by 1988. And by 1990, they expected ASICs to be a very profitable $20 billion business, usurping as much as half of the IC market. It was the direction in which logic was going. The chip makers had to be there.

Today, it's clear that these projections were wrong. Combined, gate arrays and standard cells will do about $4.2 billion this year, about $6 billion short of the mark. The biggest goof was in the area of standard cells — parts that use ultra-sophisticated software tools to produce a fully customized, denser chip. Instead of meeting analysts' projections of over $5 billion this year, the market for standard cell ICs will barely top $1.4 billion, according to ICE. It has been stunted by the absence of adequate cell libraries consisting of complex, high-performance cells — such as 16-bit and 32-bit microprocessors —and the lack of easy-to-use tools.

Gate array growth

But the lackluster growth of standard cells is only one part of the story. Gate arrays have indeed met sales projections. The gate array market will top $2.8 billion this year, by far the lion's share of the ASIC business. But for the most part, the production of these parts has become the kind of business that chip makers don't want to — or need to — be in.

Gate arrays, parts in which the chip maker customizes only the final layers of metallization that interconnect tens of thousands of gates, has turned into a cutthroat, commodity business. With 75 to 100 vendors offering similar products, prices are driven down and margins are squeezed. While there are some lucrative niches in the gate array business — Motorola, for example, reportedly is doing a thriving business in the high-speed emitter-coupled logic segment — the bulk of the gate array business, utilizing complementary metal-oxide semiconductor technology, has followed a ravaging path into commodity land.

The major firms have not abandoned R&D, but the urgency to offer a broad ASIC line is subsiding

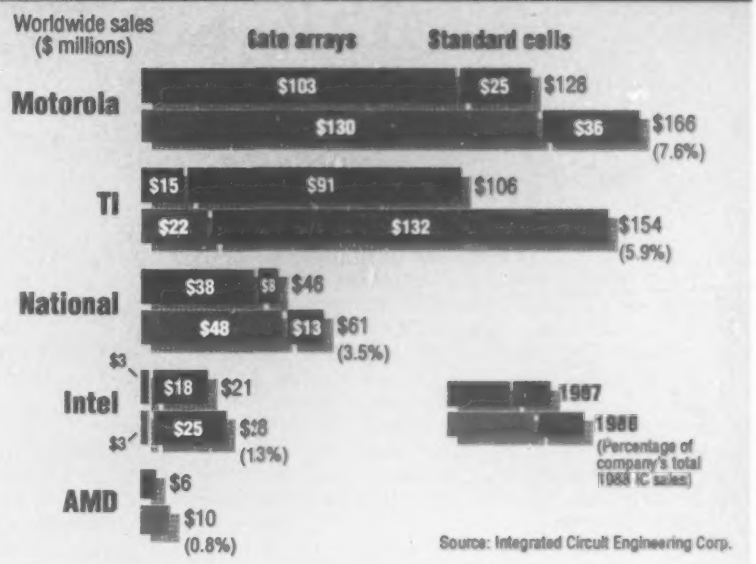
While gate arrays were becoming commodities over the past four years, the major U.S. chip makers were busy deemphasizing commodities and shifting their businesses toward proprietary, high-margin products. TI, for example, is said to have spent lavishly to design proprietary products in a number of lucrative, high-margin niches such as digital signal processing and grahics processing. National, too, is five years into a product transition that emphasizes proprietary products over the commodity "jellybeans" for which it established its reputation.

National says that about 40% of its business now is proprietary products. And TI executives say that half of their business is noncommodity chips. The entire industry, in fact, has seen remarkable results from its efforts to emphasize proprietary design and its efforts to protect exclusive designs from becoming multisourced commodities. Five years ago, points out Drew Peck, an analyst with Donaldson Lufkin Jenrette Inc., jellybean commodities generated 80% of U.S. semiconductor industry revenue and proprietary products produced the remaining 20%. Today, in contrast, commodities only represent 40% of the business. Proprietary products produce a whopping 60% of industry revenue. "It's flip-flopped dramatically," says Peck.

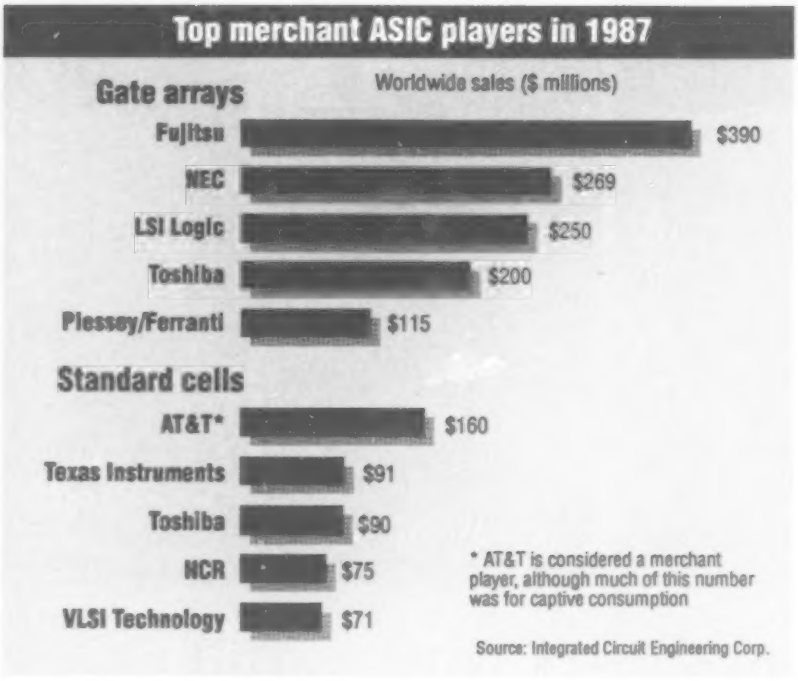
A haven from price erosion

The effect of this shift is that jellybean producers now have a haven from the low-profit commodity business — and a haven from the price erosion in gates and other commodities that the proliferation of gate arrays is causing. With this in mind, it's understandable that commodity gate arrays do not excite the major U.S. chip makers. Of the big five, only TI, National and Motorola offer CMOS gate arrays and of these, only

ASIC sales of the big five U.S. chip makers



Source: Integrated Circuit Engineering Corp.



one, National, appears to be placing any emphasis on them. TI's view is typical. Gate arrays are good for offering breadth to an ASIC line, says Wally Rhines, executive vice president of Texas Instruments' semiconductor group. Without breadth or "something really spectacular," says Rhines, "customers won't take the time to install your design tools and integrate you into their design environment." TI, he says, doesn't expect to become a leader in gate arrays.

But more than merely relieving the pressure to become gate array leaders, the industry-wide shift to proprietary products has reduced the need to become standard cell leaders as well. If customers require the complex functions offered by a proprietary chip, such as a 16-bit microprocessor or network controller, they have no choice in the matter. These functions are only available today as standard products. As Daniel Hutcheson, president of San Jose-based VLSI Research says: "Companies are differentiating their products in ways other than [by offering] ASICs." Intel's vice president, Dave House, puts it another way: "Our product is the Intel architecture." The implementations, as standard products or ASICs, are only "delivery mechanisms."

Of course, chip users will not always have just one "delivery mechanism" — standard products — available to them. Cell-based ASICs will eventually become a means of offering a vendor's complete portfolio of proprietary products. Eventually, libraries of cells will become the source of considerable competitive advantage for certain chip makers as they fill them with complex, proprietary cells such as 80386 and 68020 microprocessor cores, according to analyst Peck. Just as today, chip customers can only buy a 386 microprocessor from Intel, chances are that tomorrow, chip designers will only be able to do ASIC designs using an 80386 core if they are Intel ASIC customers.

Cell libraries will become the source of competitive advantage for chip makers

Each of the chip makers has taken the first step toward offering its products as ASICs by adopting a cell-based design methodology for designing new products. Cell-based design involves designing chip circuitry as modular building blocks, or cells. Once done, the chip maker can reuse the same cell in designing other standard products that need that particular function, say, a timer/counter or a microprocessor core. The cell can also become part of a standard cell library, which customers can use for their own ASIC designs.

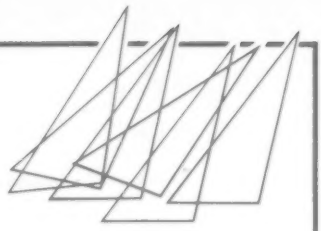
Deriving a competitive advantage

But it will be some time before the microprocessor leaders try to derive a competitive advantage in the ASIC marketplace from their cell libraries. Perhaps the biggest problem is that today's popular proprietary products were never designed to be incorporated into a cell library. And the task of converting these products to cells for a library is monumental, according to Dave House of Intel. In fact, Intel had scheduled to have products such as its 80186 16-bit microprocessor in its cell library by last January. It is still not ready. House now says that it would take all of Intel's engineers a year to convert its proprietary standard products to cells.

So far, cell libraries from companies such as Intel and Motorola contain nothing more complex than an 80C51 or 68C05 microcontroller — 8-bit processors useful for industrial control applications. Most of the other cells contained in the libraries of the major chip makers are small- and medium-scale integration (SSI and MSI) functions and a few peripheral circuits.

And despite offering considerable lip-service in the past to the idea of building up cell libraries, companies such as Intel and Motorola are not placing much emphasis on converting older products to cells. "If I felt that doing a standard cell library was my No. 1 priority, that's where I would have most of my resources," explains Tommy George, assistant general manager of Motorola's Semiconductor Products Sector. "But with our [standard] product portfolio, we don't view it that way."

For Intel, House says, the focus is not on placing past designs into its cell library, but on changing its methods so that new standard product designs can flow into the future-generation cell library, which will use 1-micron technology. Although Intel has a library using 1.5-micron technology, which may see the entry of some existing standard products,



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"We're not racing to boost that," says House. "The real emphasis is on the longer-term direction — and that's 1 micron. Products will be designed once and will automatically appear both as standard products and in standard cell libraries."

Bolstering today's anemic cell libraries is only one of the tasks that lay before the big five in making a future standard cell business. Chip makers must make their CAD software easier to use by customers. It is one thing for a chip maker's seasoned IC designers to use its tools, but quite another for customers — systems designers unsophisticated in the art of chip design — to use those tools. The tools need to be made "friendly" to the lay user, and they need to be better documented.

User-friendly tools

Today, their tools' lack of "user friendliness" and poor documentation presents a major support problem for chip makers. "Our tools have not been to the level that the customer could handle [the design] entirely himself," says House. Currently, he says, Intel must provide customers far more personalized support, or "handholding," than it would like.

The five top chip makers have dealt with this problem by keeping their lists of ASIC customers down to a relative few. Although none of the chip makers will reveal how many ASIC customers they currently have, each said it screens potential ASIC candidates based on the account's production volumes, its ability to complete the design with minimal support and its strategic importance to the chip maker. National, for example, wants to see capable customers with a minimum of $400,000 annual production runs of an ASIC, according to Jim Smaha, executive vice president of National's semiconductor group. National will go lower, he adds, for the right customer.

For those that qualify to be ASIC customers, the obvious tack is for chip makers to support them in using chip makers' CAD tools. In some cases, however, a chip maker will assign its own engineers to do the design in house. Advanced Micro Devices has the most exclusive ASIC strategy of all the big five. AMD will not place tools in customers' hands and has no intention of doing so, says Tony Holbrook, AMD's president. But the company will work with very large customers to make alterations to existing cell-based standard products, creating what it calls "customer-specific" ICs. "We are not a custom-house," says Holbrook emphatically. But, he says, "the ASIC need can be met in a number of ways."

Chip makers have been doing custom designs for their large customers for years — long before the advent of the term "ASIC," points out Motorola's George. And many of the big five continue to do these designs. The new cell-based software tools make the task of modifying existing standard products and developing new ones far simpler than before. But despite the fact that vendor-designed "ASICs" obviate the need for chip makers to adapt their tools for use by customers, this is not the long-term answer to the problem of providing ASICs to the marketplace.

Chip makers must make their CAD software easier to use by customers

Big customers want to use the tools themselves to create their own designs, says Motorola's George. This allows them full control over the design process — and the ability to keep more of their design proprietary. Agrees Intel's House: "The whole idea of ASIC is that customers do the design."

As such, the long-term ASIC strategies of the rest of the top chip makers must involve placing tools in customers' hands. Many analysts point to TI as the major company doing the best job in ASICs today. Certainly, with well over $100 million in standard cell sales, according to ICE, TI has more agressively pursued the task of building up a standard cell business than the others.

But the remaining four largest companies, and those with the hottest microprocessors, are taking it easy in ASICs. For now, you'll have to be an influential customer to get what you want in ASICs from the big five. They've got their hands full with standard products. □

How to survive and prosper in the ASIC world

As the ASIC marketplace grows, smaller companies are finding some very profitable niches, while challenging the limits of the present technology

BY JEFFREY BAIRSTOW

Despite the domination of the U.S. merchant semiconductor industry by the "big five" — Advanced Micro Devices Inc., Intel Corp., Motorola Inc., National Semiconductor Corp. and Texas Instruments Inc. — start-ups keep coming up faster than kudzu. Nowhere is this more true than for makers of application-specific integrated circuits. "The number of emerging technologies and new ideas means that the industry has not yet reached its mature stage," says Andrew Kessler, a senior industry analyst with PaineWebber Inc., New York City. Companies founded a few years ago, often by grizzled industry veterans, are just getting into their stride with novel ASIC products and are nipping at the ankles of the more well-established traditional ASIC vendors.

Indeed, the major suppliers of conventional gate arrays and standard cell devices, the two major classifications of ASICs, are continuing to experience high-growth years, but with severe price competition from the increasingly aggressive major Japanese semiconductor makers. However, the booming market for personal computers and their peripherals, in particular, is leading to lucrative opportunities for newer companies much smaller than the ASIC market leaders.

This year, the leader in the gate array market, that doesn't use a significant portion of its production in house, is expected to be LSI Logic Corp., Milpitas, Calif., according to Scott Hudson, an analyst with the market research firm Integrated Circuit Engineering Corp. (ICE), Scottsdale, Ariz. (Japanese leaders, such as Fujitsu Ltd. and NEC Corp., use about 40% for captive applications, says Hudson.) Founded in 1981, LSI Logic has produced some of the densest CMOS gate arrays with more than 50,000 usable gates. However, gate arrays are becoming more of a commodity business, notes Rodney Smith, president of Altera Corp., Santa Clara, Calif., a programmable gate array maker that has carved a profitable niche in that business. Consequently, he says, smaller companies cannot compete directly with large volume suppliers, such as LSI Logic or its Japanese competitors.

In the standard cell arena, the two leaders (after TI and Toshiba Corp.) are NCR Microelectronics, Colorado Springs, and VLSI Technology Inc. (VTI) of Santa Clara, says ICE's Hudson. ICE projects that NCR will do $94 million in CMOS standard cell devices and VTI will sell $80 million in 1988. Both companies have done well because they can offer substantial libraries of standard cells and have excellent suites of complex design tools. However, for smaller companies, the cost of providing such extensive libraries and sophisticated design tools is rapidly becoming prohibitive, to say nothing of the cost of building a wafer fabrication facility. Nonetheless, plenty of opportunity still exists, says PaineWebber's Kessler, for companies that are "adaptive to their customer's desires."

Although the big five have made some attempts to get into the ASIC business (see related story), the real action is among the little guys. The simple fact of the matter is that cus-

"We could grow faster," says Xilinx founder Bernard Vonderschmitt, "but we need [more] marketing support"

tomers will beat a path to the door of the outfit with a better mousetrap. "If you can provide the world with higher integration, lower cost and higher performance [smaller, cheaper, and faster], not only will more units be sold of current products, but new applications become feasible, creating markets never before in existence," says Kessler.

More responsive

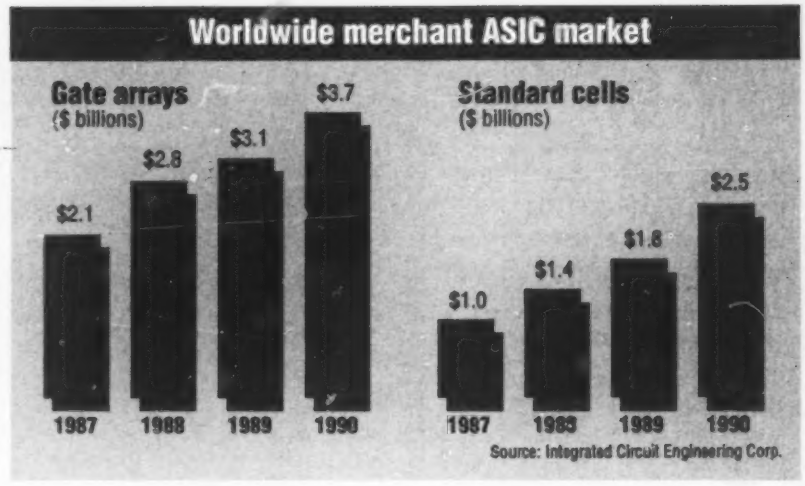
There are a few common threads running through the new successes of the ASIC field. Not only do these upstarts often have a lead on some new variant of semiconductor technology, but they are frequently led by battle-scarred veterans of the industry. Often, these are guys who implicitly understand both the technology and the no-holds-barred rules of a highly competitive business. They are also practiced scramblers who will doggedly chase a new market and adapt their products accordingly. And, these smaller players are often much more responsive to customer needs. Isn't that what application-specific means?

Take, for example, Xilinx Inc. of San Jose. Founded in 1984 by Bernard Vonderschmitt, the former general manager of Zilog and one-time general manager of RCA's solid-state circuit division, together with Ross Freeman, another Zilog graduate, the company has found a profitable niche in programmable gate arrays (PGAs), using its own patented architecture. Unlike conventional gate arrays, the Xilinx PGA's are programmed by the end user, rather than the gate array maker. The result is a standard part that can be programmed (and reprogrammed) at will by the end user with software that costs less than $5,000 and runs on an IBM PC AT or compatible system.

Xilinx's product offerings range from a 1,200-gate array, priced at under $8, to a recently announced 9,000-gate device that sells for $250. The technology is highly suitable and extremely cost effective for production volumes of under 25,000 per year, notes Vonderschmitt. Demand is strong for PGAs. "We expect around 8,000 gate array designs in 1988 with our PC-based development system, which will be about 40% of the total gate array designs this year," claims Vonderschmitt.

This year, the highly profitable Xilinx expects to do $30 million, according to Vonderschmitt. "We could grow faster," claims Vonderschmitt, "but we need to bring more horsepower to bear on marketing support and sales, for example." For now, at least, customers are flocking to Xilinx's door, mainly from the personal computer industry, where time horizons are incredibly short and the rate of product change remarkably rapid.

Even AMD, through its Monolithic Memories Inc. subsidiary, has taken note of Xilinx's success, says Vonderschmitt, and has licensed the PGA technology. Analysts expect the AMD deal to greatly expand the market for PGAs. "The task that lies ahead [for Xilinx] is to expand the market for the PGA by proliferating development systems — getting designers hooked — and then throwing new products at them as fast as they can handle them," says PaineWebber's Kessler.



Although the big five have attempted to get into ASICS, the real action is with the little guys

Lattice turnaround

At the lower end of the programmable logic device (PLD) market, Lattice Semiconductor Corp., of Hillsboro, Ore., appears to be turning around after several troubled years following its start in 1983. Now under the leadership of Norman Winningstad, the former founder and chairman of Floating Point Systems Inc., the manufacturer of high-speed array processors, Lattice is focusing its efforts on electrically erasable CMOS gate arrays that are direct replacements for Monolithic Memories programmed array logic (PAL) devices, but are faster and can be reprogrammed. The company expects sales of more than $12 million in 1988, according to Winningstad.

Lattice has also chosen the route of offering better performance than its competition, says Bill Smith, vice president for marketing. Lattice is the only supplier of 15-nanosecond programmable gate arrays, says Smith. The company has recently announced a 12-nanosecond product and expects to go to 10 nanoseconds very shortly, according to Smith. Consequently, Lattice products can compete with bipolar PLDs but offer comparable speeds at lower cost. Sales have been very strong in Japan, where "there are no electrically erasable PLD manufacturers and we can offer 100% testability, a feature the Japanese love," notes Smith.

The technology of erasable PLDs is being pushed even further by Altera Corp., with its Multiple Array Matrix (MAX), which will triple the density and double the performance compared with conventional PLDs in the same package sizes, according to David Laws, vice president for marketing for Altera. This means a PLD with 5,000 gates and system clock

speeds of up to 40 MHz. Altera's intention is to offer its new PLDs as alternatives to conventional TTL SSI and MSI parts. "One MAX device has the potential to replace 50 or more TTL packages," says Laws.

Altera was started in 1983, by Robert Hartmann, formerly with Signetics Corp.; James Sansbury, formerly with Hewlett-Packard Co., and Paul Newhagen, formerly with Fairchild Semiconductor Corp. The president, Rodney Smith, was general manager of the linear division of Fairchild. Thus, Altera also has a management team with considerable experience in the semiconductor industry. As with Xilinx, the strategy for Altera has been to offer a range of standard programmable parts with a relatively inexpensive set of development tools for the IBM PC AT that allow customers to design and program custom logic circuits themselves, notes Smith. Altera expects to do around $40 million in 1988, says Smith.

Although the basic premise of an ASIC company is usually to permit the customer to design chips to suit a particular application, the same design techniques can be used to produce complex standard parts for limited production. A case in point is Cirrus Logic Inc., of Milpitas, Calif. Cirrus Logic has developed a set of IC design tools for full custom standard cell designs which it not only offers to its customers but also uses internally to design some very successful products. For example, only six months after the announcement of the IBM PS/2 line of personal computers, Cirrus Logic had developed a VGA-compatible graphics processor chip that is also backward compatible with earlier graphics standards, such as CGA, EGA and Hercules.

That VGA part was the first on the market, by three to six months, according to Michael Hackworth, president of Cirrus Logic. In fact, this chip has found widespread use in many IBM clone machines and add-on graphics boards. Similarly, Cirrus has used its own design tools to produce a hard disk controller that can handle transfer rates as high as 20 megabits per second, without interleaving. According to the company, this chip will make possible a fast, half-height 20-megabyte hard disk for under $200. Not content with success in graphics and disk controllers, Cirrus is also offering a controller for laser printers that has the potential to double or even quadruple the speed of Postscript laser printers.

Altera's Rodney Smith: As gate arrays become a commodity product, it's more difficult for smaller firms to compete

This philosophy of using ASIC techniques to design custom chips that are then marketed by the ASIC company itself has been taken one step further by Integrated CMOS Systems Inc. (ICS), of Sunnyvale, Calif. ICS designs and manufactures custom chip sets and board-level products based on its own proprietary CMOS gate arrays. The principals of ICS, notably the president Lin Wu; vice president for engineering Laurence Cooke; and vice president for planning Symon Chang; are all "fugitives" from Storage Technology Corporation's Computer Research Corp., where they were involved in the design of IBM-compatible mainframe systems. ICS' focus is on midrange, high-performance computer manufacturers that are attempting to implement lower-cost redesigns of existing systems or higher-performance new designs, according to Tom Miller, vice president for sales and marketing for ICS.

New ASIC firms are finding niches with novel products

RISC chip sets

For ICS, the company's first big design hit is the recently announced Apollo DN 10000, a reduced instruction set computing workstation, which is based on a set of 10 30,000-gate CMOS gate arrays from ICS. "Our next design for Apollo will achieve the same power and performance with only five arrays," predicts Miller. Although the company will not give details, ICS is also working on similar chip sets for a U.S. mainframe computer maker and a Japanese minicomputer manufacturer.

While Cirrus Logic and ICS are both digital design companies, one ASIC company even offers a triple threat — digital technology, analog technology and electrically erasable PROM (programmable read-only memory) on the same chip. There are many applications, from automobiles to telecommunications, that require both analog and digital technology, which is typically provided by gate arrays together with analog chips and discrete components on a printed circuit board. Sierra has gone one step further by integrating three technologies on one device. Sierra's first product in this form is a 1200/2400 baud modem for Toshiba laptop computers. Clearly, Sierra believes in the better mousetrap theory.

Although much has been made of the general malaise affecting the U.S. semiconductor industry in recent years in the light of tough competition from Japan and the newly industrializing countries of the Pacific Rim, innovation continues, particularly in the smaller U.S. companies, notes PaineWebber's Kessler. "Innovation just does not quit in the semiconductor industry. Everyone is full of new ideas and most of the big companies do not have the resources to chase every possible idea," says Kessler. "In almost every case, new companies start with a base technology different from everyone else's and leverage this base through continued new product offerings." While most of the big five are sitting on their hands on ASICs, smaller startups are pushing the limits of technology and improving design techniques to the benefit of systems engineers both in the U.S. and overseas. □

Going public: To get the money, you gotta be great

The IPO market may appear robust, but investors are going only for quality companies with great financials — especially if they're software firms

BY RAY WISE

After having been nearly buried under last October's crash on Wall Street, the market for initial public offerings (IPOs) is alive and well. But it's as selective as a debutante's coming out party, so top executives of companies considering going public have some careful thinking to do.

About 15 or 20 ventures now go public monthly — mainly technology companies and closed-end investment funds — compared with only four or five per month right after the crash. And the batch of fledgling companies waiting in the wings is rumored to be large.

"The market for IPOs is very strong," says Terence Tehranian, an associate in the corporate finance department of Hambrecht & Quist Inc., San Francisco-based investment bankers. While the recent robustness contrasts sharply with late 1987 conditions, activity has not reached pre-crash levels, and only the better companies are coming out.

That point was proved recently at Index Technology Corp. The 5-year-old Cambridge, Massachusetts-based maker of computer-aided software engineering (CASE) tools impressed investors with its tight management controls and strong record of sales and profits growth — enough to pull in $19.2 million in IPO funds, $15 million of which went to finance growth and the rest to compensate early investors.

Dealings in IPOs, in fact, have undergone a quantum change since the heady summer of 1987, when the Dow topped 2,700 and companies were going public at twice the current rate. Some really did not qualify as freestanding ventures. "We saw too many companies that were too small, too inexperienced and did not have broad enough product lines," recalls Roy C. McKay, vice president of Scudder, Stevens & Clark, a Boston investment brokerage. "Some of them would have made good little divisions of other companies."

Not so these days. "There is a demand for quality," says Barry Gordon, president of the American Fund Advisors (AFA) group of technology-dominated mutual funds in New York. The only kinds of companies that are coddled in the current IPO market are those that are well established and can boast impeccable financial credentials, or are firmly positioned in a swiftly growing sector like cellular radios.

Managements mulling a maiden stock offering in this environment are advised to proceed cautiously. "If you are not really ready to go public, you won't be able to raise the money you need," Gordon cautions. "Better stay private awhile. There is plenty of venture capital out there." "There is no shortage of capital, only a shortage of good companies to invest it in," adds McKay.

To sort out companies that are ready to go public from those that aren't, Katherine R. Kirk, a principal in the Boston office of Hambrecht & Quist, uses three criteria: profitability, competitiveness of the product line and depth and breadth of management. Kirk wants an emerging venture to have posted four back-to-back quarters of profitability and to offer good profits prospects in the next four quarters too.

Industry sector is another factor that can influence an IPO's outcome. "The three sectors that are best received by the investing public are software, software and software," says Kirk. Software companies have

"Our IPO gives us credibility with our customers," says Burt Rubenstein, Index Technology's research vice president

Dave Bradley

dominated new offerings in the last few months — companies like database management firm Relational Technology Inc. — but there have been a few hardware firms too, such as 3.5-inch hard disk drive maker Conner Peripherals Inc. and graphics products maker Sigma Designs Inc.

Fussy Wall Street

Reflecting market fastidiousness, some companies have launched their stocks at prices so moderate by historical standards as to lure institutional investors, some of which usually shun new issues.

A stock making its debut in today's market is likely to be priced at the low end of the range targeted for it by the investment bankers, even though it may have emerged at the top of its range last summer. In terms of the stock price/corporate earnings multiple, ventures that would have commanded a multiple of two or three times that of the market are coming out right on the market, or at a slim premium — 20%, or at most 30%.

Another symptom of the investing public's skepticism is that the discounts imposed on new issues, relative to established stocks in the same industry sectors, have widened to around 15% from the usual 5% or so.

Although demand for IPOs is strong upon launch, many of the buyers who snap them up sell them at once for quick profit. The "flipping" can cause an entire issue to trade within a few days of its introduction.

"This is a totally unforgiving market," notes the AFA's Gordon. A company expected to post quarterly earnings of 10 cents a share that actually reports eight cents, can watch in horror while its share price skids 50%. Technology stocks are especially vulnerable to investor intolerance or outright caprice. This shabby treatment does not even spare the bigger names, as was demonstrated a while back when Microsoft Corp.'s shares tumbled 15 points to 52 in 17 days, for no apparent reason. "There was no negative news," reports one portfolio manager.

One factor that newly arrived shares have going for them is their pricing, which recently has been highly attractive from the investor's viewpoint. The awesome power of the discount showed up clearly in the first six months of 1988, when the performance of the neophyte shares soundly trounced that of the stock market at large. In fact, Standard & Poor's index of 80 recently emerged stocks gained more than 25%, compared with under 11% for S&P's mainstream 500-stock index.

Who went public in 1988

A sampling of 1988 electronics IPOs, $10 million and up

Issuer	Deal size ($ thousands)	Offering date
Octel Communications	$14,700	2/26/88
Maxim Integrated Products	11,000	2/29/88
Vitalink Communications	16,500	3/4/88
Altera	22,000	3/30/88
Conner Peripherals	32,000	4/12/88
Contel Cellular	85,000	4/21/88
Relational Technology	28,000	5/17/88
Phoenix Technologies	49,500	6/14/88
Dell Computer	29,800	6/22/88
Index Technology	19,200	6/23/88

Source: Hambrecht & Quist Inc.

"Eleven of the 20 best-performing stocks in the new issues index were technology shares," notes Robert Natale, senior investment officer of Standard & Poor's Corp. In addition, the second-best performer in the top 20 was Octel Communications Corp., which is a marketer of voice-processing equipment, that surged more than 105% in the 6-month span.

"The three sectors best received by investors are software, software and software"

Index Technology, one of Kirk's clients, went public last June, raising $15 million to finance growth in CASE. The stock offering was backed by strong financials, with operating earnings per share up 25% on revenue growth of 45% last year.

Big Blue's blessing

The company had spun off from a consulting firm in October 1983, its start-up bankrolled largely by the parent organization. Index Technology signed a distribution agreement with IBM in January 1984. The move was "more for the blessing of Big Blue than for revenue growth," explains Chris M. Grejtak, vice president for marketing and sales.

Management carefully nurtured the growth of Index Technology by pursuing highly specific corporate objectives, especially in financial controls. When revenue projections failed to materialize, manpower expansion and new projects were scaled back accordingly; but when revenue surpassed expectations, deferred spending programs were wheeled out.

Venture capital was infused into Index Technology to the tune of $2.75 million in 1984 and $2 million in 1985, and the result was vigorous corporate expansion. Revenue surged from $1.7 million in 1984 to $22 million in 1987, while the payroll grew from 48 to 186.

This forced the management team to confront three options: stay private and continue to raise capital internally and through venture capitalists; seek to be acquired by a company with deeper pockets; or go public. Marketing chief Gretjak points out that Index Technology was blessed with having venture capitalists who did not try to push the company out into a premature IPO to turn a swift profit on their investment.

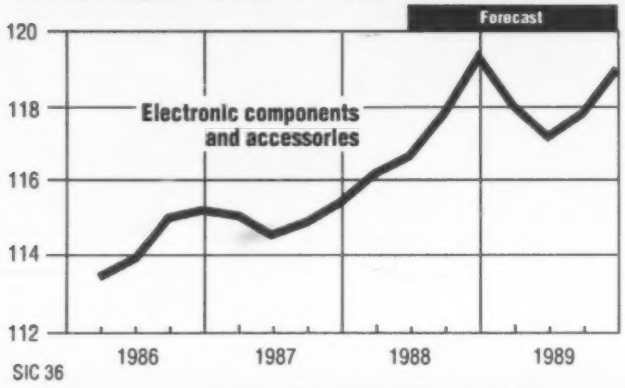
But timing is everything in an IPO. Scudder's McKay advises coming out in late fall or early winter because demand for new issues on the stock market tends to be highest in January and lowest in August.

Some participants say it's more subjective. "You are ready to go public when it 'feels' right," says Index Technology's Gretjak. "We had had a strong 1986, and 1987 was particularly strong, and at the end of 1987 prospects for the next quarter looked very good." Quarterback for the IPO was CFO J. Jeffrey Bingenheimer, and Gretjak advises other emerging companies to copy this one-person policy. "One person definitely should manage the process of going public," he says.

IPOs bring other advantages —like more capital, according to Burt L. Rubenstein, Index Technology's vice president for research and technology. He says: "It gives us credibility with our customers as a long-term company with financial strength." □

Producer price index — Electronic components

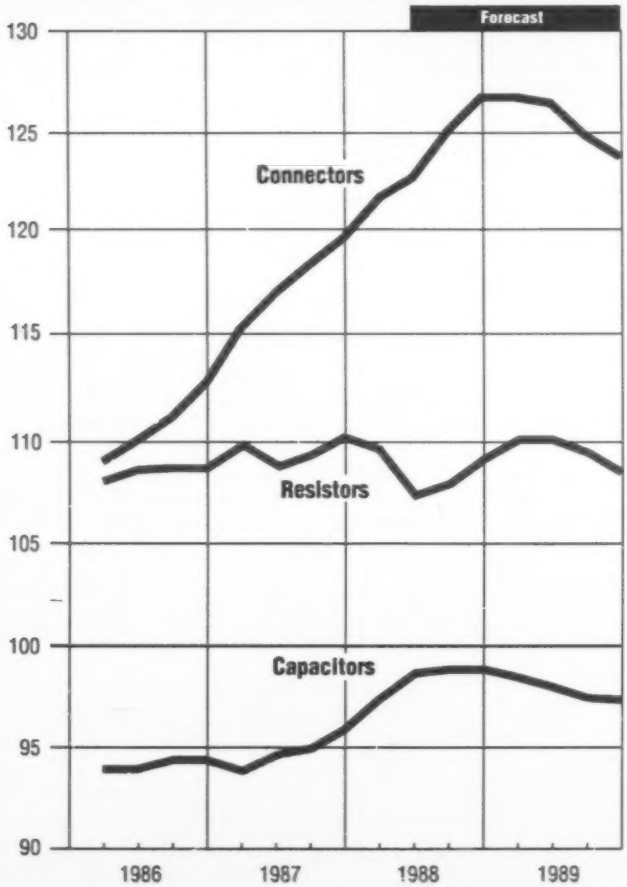
Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Passive components

Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Passive prices mixed bag so far in 1988

Prices of capacitors and connectors jumped over 4% in the second quarter of 1988 compared with a year earlier. This spring surge was not met by similar price increases for resistors; those prices dropped 1.3% in the second quarter. All in all, passive component prices, as measured by the Bureau of Labor Statistics, showed only a mixed bag in the passive price arena.

Monthly surveys of buyers made by *Electronics Purchasing* magazine suggest that passive prices have little upward pressure due to any supply-demand imbalances. According to the magazine's survey, this past summer buyers waited just about the same length of time for deliveries of connectors, capacitors and resistors as they waited a year ago. Compared with the last period that delivery times stretched with supply shortages in 1984, connector delivery times are a week shorter, resistors remain a week and a half shorter, and capacitors are two and a half weeks below 1984 summer schedules.

Inflationary expectations?

Rather than the economics of supply and demand, inflationary expectations are probably playing a bigger role in 1988's passives price picture. The summer drought which boosted Midwest produce prices could have an inflationary effect, eventually, on all electronic component prices.

That may seem like a long leap of faith from the farm to the electronics factory, but as consumer expectations of inflation rise, demand for higher wages heats up, and employers of manufacturing production workers end up passing the higher wage prices along to their buyers of components and machinery. And on it goes, creating a spiral of higher and higher inflation.

What are the chances that such an inflationary spiral will take place in late 1988 or 1989? Given the Federal Reserve Board's determination to hold inflation in check, there remains a lot of doubt that prices will see action like 1981 after the oil prices took off. Still, buyers and sellers of electronic components need to look at inflationary expectations in the whole economy, not just the electronics industry.

ELIZABETH BAATZ

Computer industry on top again

From May to June, new orders of computers and office machinery pushed up almost 4% to $5.6 billion. This is the highest monthly level since February 1985. The June figure brings first half new orders to $33 billion, an increase of 20% compared with the first six months of last year. Sales growth continues unabated. Shipments tallied $5.7 billion in June, a rise of 4% from May.

Industrial production of computer and office machinery in June dwindled less than half a percent from the strong May performance. The solid June figure brings the average second-quarter production 12% above the April through June period last year.

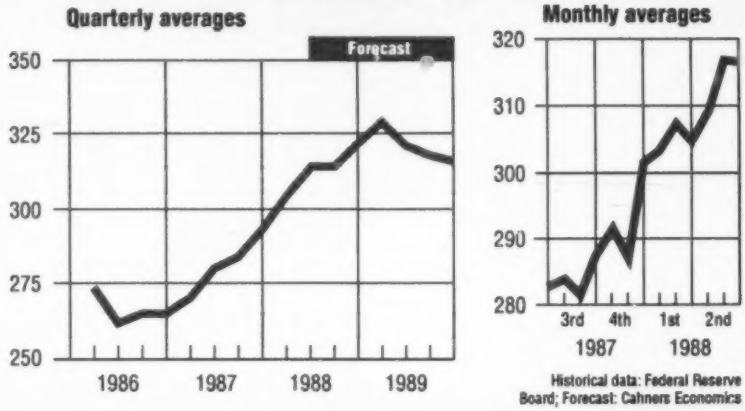
A good deal of this production is moving overseas. Through the first half of this year, computer and office machinery exports soared to $11.3 billion, a rise of 30% compared with the six months of 1987.

Computer makers continue to get a boost from domestic equipment investment spending. During the second quarter, businesses spent an annualized $40.8 billion (current dollars) for computers and office equipment, up a whopping 18% compared with the second quarter of 1987.

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics, 275 Washington St., Newton, Mass. 02158. Phone: (617)964-3030.

Computers and office machinery — Industrial production

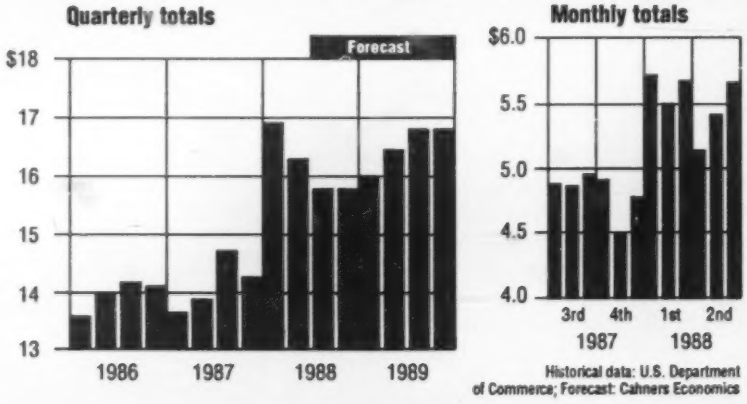
Seasonally adjusted index, 1977 = 100



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Computers and office machinery — Shipments

Seasonally adjusted ($ billions)



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

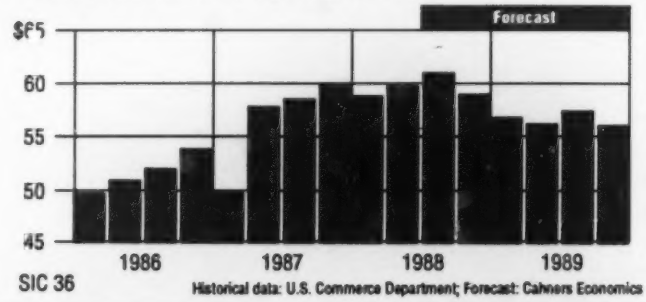
	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, June)	316.8	317.2	-0.13%	283.3	+11.82%	322.5	+1.80%
Shipments (SA, $ millions, June)	$5,683	$5,442	+4.43%	$4,578	+24.14%	$5,497	-3.27%
New orders (SA, $ millions, June)	$5,620	$5,410	+3.88%	$4,562	+23.19%	$5,482	-2.45%
Unfilled orders (SA, $ millions, June)	$18,661	$18,724	-0.34%	$19,152	-2.56%	$18,133	-2.83%
Inventory-to-shipment ratio (SA, June)	1.85	1.89	—	2.11	—	1.88	—
All employees (thousands, June)	514.8	507.2	+1.50%	483.6	+6.41%	518.3	+0.69%
Production workers (thousands, June)	168.8	167.9	+0.54%	161.8	+4.33%	166.3	-1.51%
Exports ($ millions, June)	$1,935	$1,842	+5.03%	$1,587	+21.93%	$1,992	+2.96%
Imports ($ millions, June)	$2,035	$1,773	+14.80%	$1,574	+29.28%	$2,019	-0.80%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

Electrical machinery — New orders

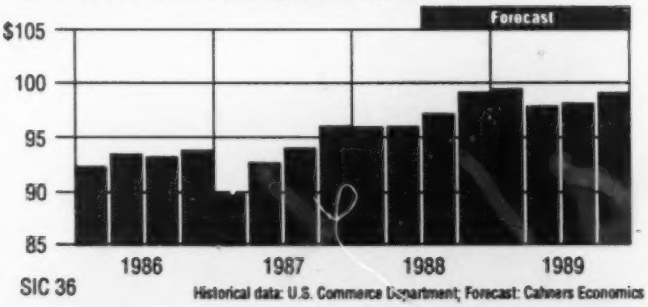
Quarterly totals, seasonally adjusted ($ billions)



SIC 36 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electrical machinery — Unfilled orders

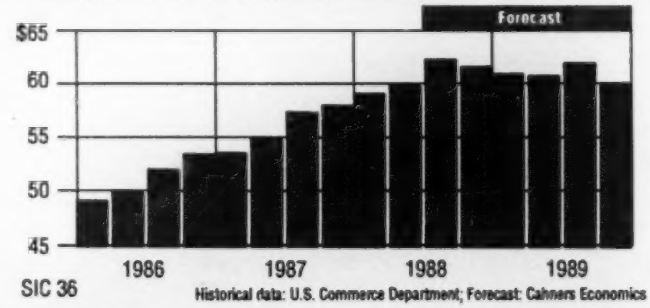
End-of-quarter totals, seasonally adjusted ($ billions)



SIC 36 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electrical machinery — Shipments

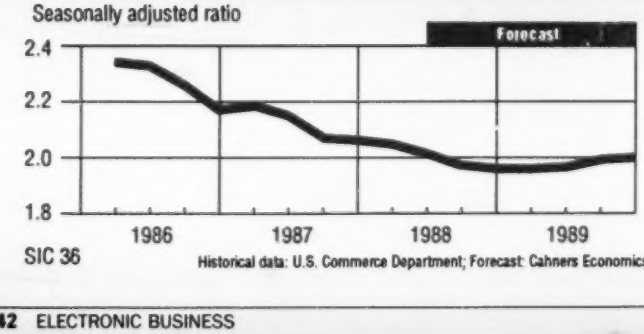
Quarterly totals, seasonally adjusted ($ billions)



SIC 36 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electrical machinery — Inventory-to-shipments

Seasonally adjusted ratio



SIC 36 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Warning signals flash for electrical machinery

Second quarter data for the electrical machinery industry has flashed a warning signal: Back orders fell $57 million from the first quarter to the second quarter. Although this drop is an extremely small share of the total $96.1 billion of back orders, the decline was the first one in the past seven quarters.

The reason back orders have fallen: new orders have not continued to outpace shipments. Even though new orders rose 1.5% and shipments inched up 1.4% from the first quarter of 1988 to the second, orders totaled $59.77 billion, just shy of the $59.83 billion of equipment that was shipped. As a result, the book-to-bill ratio for this industry remains just below the critical 1.0 level.

These warning signals so early in 1988 do suggest that electrical and electronic equipment shipments will see a slowdown in 1989. Cahners Economics' forecast for shipments shows only a 0.4% gain in 1989 after an 8.2% jump in 1988. This forecast is probably one of the most pessimistic for the industry.

. . . But some green lights still glowing

Two factors could help push 1989 growth higher than Cahners' forecast. First, inventories relative to shipments remain extraordinarily low. Just-in-time inventory policies and management's concern about the continued buoyancy of this economic recovery have kept inventory in check. Without excess inventory, tomorrow's economic slowdown will positively not result in anything resembling an economic crash. And that is very encouraging news.

Second, the export market will continue to boost U.S. shipments next year. The impact of a lower dollar and cheaper U.S. goods abroad has taken a long time to be felt, so 1989 is expected to be another solid year for exporters.

The so-called "electrical" machinery industry is a broad collection of different industries. So far, the winners in the 1988 shipments race are electronic components and communication equipment, which together make up over 50% of the total electrical machinery industry. Placing second is electrical transmission and distribution equipment and miscellaneous electrical equipment. In last place with declining shipments is radio and TV, and household appliances.

ELIZABETH BAATZ